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ARTICLE

Transnational Governance of Soybean Land Use in South America: A Polycentric Approach

Zhang Min[1] and Fernando Romero Wimer[2]

[1] Center for American Studies, Nanjing Agricultural University, Nanjing, Jiangsu (China)
[2] Latin American Institute of Economics, Society and Politics, Federal University of Latin American Integration, Foz do Iguaçu (Brazil)
Corresponding author: Zhang Min, E-mail: springzm@njau.edu.cn

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Abstract
The expansion of soybean cultivation in South America has created substantial economic prosperity but has also raised a series of unsustainable land-use issues. Considering the telecoupling system (a system of socio-ecological interactions between distant places) between South America and its soybean trade partners, transnational governance could play an important role in addressing these issues. To achieve effective governance of this specific telecoupling system, this study applies a polycentric approach to improve the existing transnational governance and identify more suitable governance arrangements. This study first explores the telecoupling system and the existing transnational governance system of soybean land use in South America. It then compares the existing governance system with the polycentric approach to examine the gaps between them. Based on these analyses, suggestions for improving the governance system are provided, including increasing the involvement of major governance centres, improving public-private partnerships, and establishing a knowledge-sharing platform.

Keywords: Soybeans; Land-use governance; South America; China; Telecoupling; Polycentric governance

1. Introduction

Soybean is a flexing crop that integrates the functions of grain, oil, and feed.[1] Since the 1960s, with the increasing demand for soybeans in international consumer markets, land-use changes caused by global soybean production have garnered attention. According to statistics of the Food and Agriculture Organization of the United Nations (FAO), the global soybean harvest area increased 5.6-fold between 1961 and 2022, from 23.82 million hectares (ha) to 133.79 million ha.[2] Currently, the global soybean harvest area accounts for more than 9% of the world's arable land, making soybeans the world's fourth-largest crop after corn, wheat, and rice.[3] With the

1 S.M. Borras Jr. et al., 'The Rise of Flex Crops and Commodities: Implications for Research' (2016) 43(1) *The Journal of Peasant Studies*, pp. 93–115.
2 FAO, 'FAOSTAT', available at: https://www.fao.org/faostat/en/#data.
3 Ibid.

development of the world economy and global population growth, the world's soybean demand is projected to increase,[4] which will continuously push global soybean land use forward.

Soybeans reached South America relatively late. The earliest report seen on the introduction of soybeans into South America was published in 1882.[5] However, after a slow start, soybean production in the continent has grown exponentially in recent decades. The harvest area in South America grew from 0.26 million ha in 1961 to 62.91 million ha in 2022,[6] showing a 242-fold increase. Currently, South American nations contribute to more than half of the world's soybean production.[7] The main impetus for the soybean boom in South America is the demand for oil and animal feed in the international market. Most of South America's soybean exports are destined for Europe and China, where crushed soybean slurry is mixed with corn to feed pigs and chickens.[8]

Although the expansion of soybean cultivation in South America has created substantial economic prosperity, [9] it has also involved significant environmental and social costs, such as deforestation in the Amazon region,[10] biodiversity losses in the Cerrado region,[11] overuse of agrochemicals in soybean farmlands,[12] and land disputes in Indigenous communities.[13] Given that distant international consumer markets are important drivers of the change in soybean land use in South America, transnational governance can serve as an important instrument for addressing the unsustainable consequences of soybean land use in South America. However, traditional international governance is subject to the principle of sovereignty, which grants supreme jurisdiction over the respective territory, and which is likely to trigger accountability deficits in the governance of transnational environmental harm.[14] Therefore, it cannot provide an ideal solution for the transnational governance of sustainable soybean land use in South America.

The concept of telecoupling refers to socio-economic and environmental interactions over distances, which was first proposed in 2008 with the world becoming increasingly connected through distant processes, such as international trade and flows of ecosystem

[4] M. Messina, 'Perspective: Soybeans Can Help Address the Caloric and Protein Needs of a Growing Global Population' (2022) *Frontiers in Nutrition*, article 909464.

[5] T. Hymowitz & C.A. Newell, 'Taxonomy of the Genus Glycine, Domestication and Uses of Soybeans' (1981) 35(3) *Economic Botany*, pp. 272–88, at 278.

[6] FAO, n. 2 above.

[7] X.-P. Song et al., 'Massive Soybean Expansion in South America since 2000 and Implications for Conservation' (2021) 4(9) *Nature Sustainability*, pp. 784–92.

[8] M. Abel, 'Soy Power' (2021) 7(12) *Nature Plants*, pp. 1533–5.

[9] A. Cattelan & A. Agnol, 'The Rapid Soybean Growth in Brazil' (2018) 25(1) *Oilseeds and Fats, Crops and Lipids*, article D102.

[10] M. Lima et al., 'Demystifying Sustainable Soy in Brazil' (2019) 82(3) *Land Use Policy*, pp. 349–52.

[11] L.L. Rausch et al., 'Soy Expansion in Brazil's Cerrado' (2019) 12(6) *Conservation Letters*, article e12671.

[12] F.E.A. Coelho et al., 'Brazil Unwisely Gives Pesticides a Free Pass' (2019) 365(6453) *Science*, pp. 552–3.

[13] S. Sauer, 'Soy Expansion into the Agricultural Frontiers of the Brazilian Amazon: The Agribusiness Economy and Its Social and Environmental Conflicts' (2018) 79 *Land Use Policy*, pp. 326–38.

[14] M. Mason, 'The Governance of Transnational Environmental Harm: Addressing New Modes of Accountability/Responsibility' (2008) 8(3) *Global Environmental Politics*, pp. 8–24, at 8.

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services.[15] In February 2011, the American Association for the Advancement of Science (AAAS) held a symposium titled 'Telecoupling of Human and Natural Systems' to obtain insights into the complexity of this concept.[16] The concept of telecoupling is a logical extension of research on coupled human and natural systems, in which interactions occur within particular geographic locations. In 2013, Liu and co-authors introduced an integrated framework of telecoupling to systematically describe socio-economic and environmental interactions among distant coupled human and natural systems – that is, coupled human and natural systems, flows, agents, causes, and effects.[17] Since then, the concept of telecoupling has started to receive widespread attention. In the first five years since the introduction of this framework, over 300 papers have cited Liu and co-authors.[18] The framework has been applied conceptually to multiple disciplinary fields, such as land-change science; species invasion; payments for ecosystem services programmes; natural conservation; and the trade of food, forest products, energy, and virtual water.[19]

Sustainability of parts does not equal sustainability of the whole. The telecoupling framework identifies disconnects in sustainability gains and losses across space, helping to bridge the gap between lost signals caused by long-distant factors[20] and realizing systems integration for global sustainability.[21] Unlike traditional international governance, telecoupling systems represent a special type of governance that arises as a result of specific linkages between distant regions.[22] To achieve effective governance of this specific type of transnational system, Oberlack and co-authors combined telecoupling theory with the Institutional Analysis and Development framework, designed by Ostrom and colleagues, and proposed a polycentric approach for the governance of telecoupled land-use systems,[23] which is more adaptive and inclusive of responses at appropriate scales.[24] Currently, the polycentric approach is being applied to the transnational governance of biofuel production and deforestation by European actors, such as the European Union (EU), EU Member State governments,

[15] J. Liu et al., 'What is Telecoupling?', in C. Friis & J.Ø. Nielsen (eds), *Telecoupling: Exploring Land-Use Change in a Globalised World* (Palgrave Macmillan, 2019), pp. 19–48, at 19–21.

[16] AAAS, 'Telecoupling of Human and Natural Systems', 18 Feb. 2011, available at: https://aaas.confex.com/aaas/2011/webprogram/Session2889.html.

[17] J. Liu et al., 'Framing Sustainability in a Telecoupled World' (2013) 18(2) *Ecology and Society*, pp. 595–613.

[18] K.E. Kapsar et al., 'Telecoupling Research: The First Five Years' (2019) 11(4) *Sustainability*, article 1033, p. 2.

[19] J. Liu et al., 'Multiple Telecouplings and Their Complex Interrelationships' (2015) 20(3) *Ecology and Society*, pp. 746–62, at 747.

[20] V. Hull & J. Liu, 'Telecoupling: A New Frontier for Global Sustainability' (2018) 23(4) *Ecology and Society*, pp. 180–8, at 184–5.

[21] J. Liu et al., 'Sustainability: Systems Integration for Global Sustainability' (2015) 347(6225) *Science*, pp. 963–72.

[22] J. Newig et al., 'Governing Global Telecoupling toward Environmental Sustainability' (2020) 25(4) *Ecology and Society*, article 21, p. 1.

[23] C. Oberlack et al., 'Polycentric Governance in Telecoupled Resource Systems' (2018) 23(1) *Ecology and Society*, article 16.

[24] C. Cvitanovic et al., 'Governing Fisheries through the Critical Decade: The Role and Utility of Polycentric Systems' (2018) 28(1) *Reviews in Fish Biology & Fisheries*, pp. 1–18.

and non-state actors in European countries, where it has led to better results than the traditional international governance paradigm.[25]

Soybean land use in South America is deeply influenced by international markets and has resulted in a series of significant socio-economic and environmental impacts; it constitutes, therefore, an excellent example of telecoupled systems through the process of soybean trade.[26] Traditional international governance, constrained by the principle of sovereignty, may not be appropriate to address the sustainability of this special telecoupled system of land use. This study applies the innovative telecoupling theory and polycentric approach to the transnational governance of telecoupled soybean land use in South America to overcome the shortcomings of the traditional international governance paradigm based on state sovereignty. In addition, it identifies new ways to promote the sustainability of soybean land use in South America through transnational governance.

This study starts by exploring the telecoupled land-use system between South American countries and their main soybean trading partners to examine the impact of long-distance factors on soybean land use in South America (Section 2). It then analyzes the existing transnational governance system of soybean land use in South America at the following three levels: (i) traditional international laws, (ii) unilateral governance in Europe, and (iii) the governance of non-state actors (Section 3). The study then compares the existing governance system with the polycentric governance paradigm and identifies the gap between them, after a brief introduction to the emergence of the polycentric approach in transnational land-use governance (Sections 4.1 and 4.2). Finally, it offers suggestions on how to improve the existing transnational governance system from the perspective of polycentric governance, including increasing the involvement of major governance centres, improving public-private partnerships, and establishing a knowledge-sharing platform through international cooperation for the improved operation of the polycentric governance system (Section 4.3).

2. Telecoupling System between South American Countries and Their Main Soybean Trading Partners

2.1. Impact of International Trade on Soybean Production in South America

Soybeans originated in East Asia and have been cultivated in this region for thousands of years.[27] The earliest records of soybean cultivation in South America appeared around the 1880s;[28] however, the crop did not attract significant attention in the region until the second half of the 20th century. In the 1960s, with the recovery of the world

[25] C. Moser & R. Bailis, 'Transnational Governance towards Sustainable Biofuels: Exploring a Polycentric View', in P. Pattberg & F. Zelli (eds), *Environmental Politics and Governance in the Anthropocene* (Routledge, 2016), pp. 117–40.

[26] J. Sun, Y.X. Tong & J. Liu, 'Telecoupled Land-Use Changes in Distant Countries' (2017) 16(2) *Journal of Integrative Agriculture*, pp. 368–76.

[27] E.J. Sedivy, F. Wu & Y. Hanzawa, 'Soybean Domestication: The Origin, Genetic Architecture and Molecular Bases' (2017) 214(2) *New Phytologist*, pp. 539–53.

[28] Hymowitz & Newell, n. 5 above, p. 278.

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economy after the Second World War and the rise of large-scale intensive animal farming in Europe, the global demand for soybeans increased rapidly. At the same time, there was a shortage in the international supply of fish meal, which was used as feed raw material and allowed chickens and pigs to be raised in confined spaces.[29] The importance of soybean protein as an animal feed additive was highlighted in 1962 when the European Economic Community (EEC) committed to opening up their oil-seed markets and binding a zero tariff on oilseeds and a 6% tariff on non-grain feeding stuffs during the General Agreement on Tariffs and Trade (GATT) Dillon Round negotiations.[30] Driven by increasing demand in the European market, South American soybeans entered a period of rapid growth, especially in nations with abundant arable land resources, such as Brazil and Argentina. According to FAO statistics, the soybean harvest area in South America increased 5.5 times between 1961 and 1970, and the import quantity of all the European countries together increased 3.3 times at the same time.[31]

South American soybeans ushered in a new development opportunity in the 1970s and 1980s. During this period, soybean production in the United States (US) declined as a result of complex international and domestic factors (such as the Cold War and the grain embargo against the Soviet Union[32]) and this provided another new market opportunity for South American soybean producers. Evidence indicates that shipments from Argentina to the Soviet Union increased fourfold during the period of the grain embargo.[33] Together with soil improvements in the Cerrado biosphere[34] and progress in soybean cultivation technology for the green revolution (i.e. the use of modern agricultural technology, such as variety improvement and agricultural chemicals, to increase food production in 1960s and 1970s),[35] South America's soybean production and trade continued to grow at a faster pace in the 1970s and 1980s. This was despite the major soybean-producing countries in South America, such as Brazil and Argentina, experiencing severe economic crises. From 1971 to 1989, the South American soybean harvest area increased about nine-fold, from 1.87 million ha to 17.35 million ha.[36]

Since the 1990s, however, the political geography of soybean production has witnessed a dramatic shift.[37] After years of reform and implementing a new policy

[29] K. Wintersteen, 'Protein from the Sea: The Global Rise of Fishmeal and the Industrialization of Southeast Pacific Fisheries, 1918–1973', 2012, desiguALdades.net *Working Paper Series No. 26*, available at: https://www.desigualdades.net/Resources/Working_Paper/26_WP_Wintersteen_Online.pdf.

[30] A.F. McCalla, 'Agricultural Trade Liberalization: The Ever-Elusive Grail' (1993) 75(5) *American Journal of Agricultural Economics*, pp. 1102–12, at 1106.

[31] FAO, n. 2 above.

[32] J.R. Tarrant, 'Food as a Weapon? The Embargo on Grain Trade between USA and USSR' (1981) 1(4) *Applied Geography*, pp. 273–86.

[33] Ibid.

[34] P.H. Abelson & J.W. Rowe, 'A New Agricultural Frontier' (1987) 235(4795) *Science*, pp. 1450–1.

[35] R. Nehring, 'Yield of Dreams: Marching West and the Politics of Scientific Knowledge in the Brazilian Agricultural Research Corporation (Embrapa)' (2016) 77 *Geoforum*, pp. 206–17.

[36] FAO, n. 2 above.

[37] G.L.T. Oliveira & M. Schneider, 'The Politics of Flexing Soybeans: China, Brazil and Global Agroindustrial Restructuring' (2016) 43(1) *The Journal of Peasant Studies*, pp. 167–94, at 167.

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(the Reform and Opening-Up policy), the Chinese economy developed significantly, with a consequent increase in the demand for food, especially high-value and high-protein foods, particularly meat and dairy products.[38] This added considerable pressure on China's agricultural production and domestic food security. To address the increased demand for food and the shortage of farmland and water resources, China considered soybean liberalization and began to purchase soybeans in large quantities from the international market,[39] allowing the country to quickly surpass Europe and Japan as the world's largest importer of soybeans. The huge demand in the Chinese market further drove soybean production in South American countries. Over the next two decades, South America's soybean exports to China increased exponentially. Brazil, in particular, has rapidly grown to become the most important soybean supplier to China; in 2013, Brazil overtook the US as China's largest source of imported soybeans.[40] According to Chinese customs data, South American soybeans accounted for over 70% of China's total soybean imports in 2023.[41]

The above analysis indicates that export to international consumer markets in distant places, such as EU nations and China, has become the main driving force for soybean land-use expansion in South America. The transnational soybean supply chain closely links South America's land-use system with the market in distant places, resulting in a series of socio-economic and environmental effects in the region, which are delineated in the following section.

2.2. Effects of International Trade on the Soybean Land-Use System in South America

From an economic point of view, the soybean trade has been of significant benefit to South America. It provided an impetus for the soybean boom and has brought a large amount of foreign exchange to the soybean-exporting countries, which is conducive to South American countries' international balance of payments. For example, the export value of Brazilian soybeans was US$ 46.66 billion in 2022,[42] accounting for nearly 10% of Brazil's total export value, while the export value of Argentinian soybeans was US$ 30.82 billion in 2022,[43] accounting for nearly 30% of the country's total export value. Soybean trade has also promoted the development of South American society; there is a strong correlation between soybean yield and macro socio-environmental indicators such as the Human Development

[38] Y. Sheng & L. Song, 'Agricultural Production and Food Consumption in China: A Long-Term Projection' (2019) 53 *China Economic Review*, pp. 15–29.
[39] H.R. Yan, Y.Y. Chen & H.B. Ku, 'China's Soybean Crisis: The Logic of Modernization and Its Discontents' (2016) 43(2) *The Journal of Peasant Studies*, pp. 373–95.
[40] M. Wang et al., 'Structural Evolution of Global Soybean Trade Network and the Implications to China' (2023) 12(7) *Foods*, article 1550.
[41] General Administration of Customs of the People's Republic of China, 'Customs Statistics', available at: http://stats.customs.gov.cn/indexEn.
[42] FAO, n. 2 above.
[43] Ibid.

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Index (HDI), with the top 10 cities with the largest soybean production in Brazil reporting higher HDI scores than the state and country averages.[44]

However, the expansion of soybean land use in South America has also led to a series of unsustainable environmental consequences. Owing to the widely adopted transgenic soybean cultivation technology, a large amount of glyphosate herbicide is used in South America's soybean farmlands, which not only damages the local environment but also introduces a significant amount of herbicide residue into the global food supply chain. According to Bøhn and Millstone, the rates of glyphosate and glyphosate-based herbicides (GBH) use in Argentina and Brazil, two of the largest soybean-producing countries, reached 3–4 kg/ha in recent years and would contribute to an accumulated amount of 2,430 tonnes of glyphosate into the global food chains from genetically modified soybeans in just one year.[45] Although glyphosate use is restricted in the EU because of its significant impact on biodiversity, Brazil, the largest soybean producer in South America, has classified it as essentially non-toxic and unlikely to cause harm to humans.[46]

Overuse of fertilizers is another unsustainable problem in South American soybean production. Brazilian soybean is intensively produced in areas with highly weathered, naturally acidic soils that render much of the native and applied phosphorus unavailable to the crop. Brazilian soybean production thus requires higher phosphorus fertilizer and lime inputs than soybeans produced in most temperate regions,[47] which not only has led to heavy contamination of the local environment but also has contributed to interfering with the global phosphorus cycle, making it among the foremost issues in the context of present transgressions of planetary boundaries.[48] Meanwhile, the large-scale monoculture model for soybean production in South America has exacerbated the concentration of power among a small number of large landholders,[49] in that most local rural residents are deprived of access to vital resources such as water and food and further excluded from decision-making bodies.[50]

During the 1990s, owing to the successful development of new varieties that could tolerate the moist, hot Amazon climate,[51] South American soybean cultivation expanded rapidly in the Amazon region. As a result, soybean expansion became a

[44] A.A.R. Ioris, 'Encroachment and Entrenchment of Agro-Neoliberalism in the Centre-West of Brazil' (2017) 51 *Journal of Rural Studies*, pp. 15–27, at 16.

[45] T. Bøhn & E. Millstone, 'The Introduction of Thousands of Tonnes of Glyphosate in the Food Chain: An Evaluation of Glyphosate Tolerant Soybeans' (2019) 8(12) *Foods*, article 669, p. 8.

[46] F. de Araújo Nascimento et al., 'Cultivated Areas and Rural Workers' Behavior Are Responsible for the Increase in Agricultural Intoxications in Brazil? Are These Factors Associated?' (2020) 27(30) *Environmental Science and Pollution Research International*, pp. 38064–71, at 38065.

[47] G. Yao et al., 'The Increasing Global Environmental Consequences of a Weakening US-China Crop Trade Relationship' (2021) 2(8) *Nature Food*, pp. 578–86, at 581.

[48] F. Lun et al., 'Influences of International Agricultural Trade on the Global Phosphorus Cycle and Its Associated Issues' (2021) 69 *Global Environmental Change*, article 102282.

[49] D. Weinhold, E. Killick & E.J. Reis, 'Soybeans, Poverty and Inequality in the Brazilian Amazon' (2013) 52 *World Development*, pp. 132–43, at 136.

[50] M.N.V. Toloi et al., 'Development Indicators and Soybean Production in Brazil' (2021) 11(11) *Agriculture*, article 1164, p. 3.

[51] D.C. Nepstad, C.M. Stickler & O.T. Almeida, 'Globalization of the Amazon Soy and Beef Industries: Opportunities for Conservation' (2006) 20(6) *Conservation Biology*, pp. 1595–603.

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main driver of deforestation in the Amazon.[52] Brazil deforested 25,540 square kilometres (km^2) of area annually between 1990 and 1995, the bulk of which occurred in the Amazon.[53] The Amazon rainforest is home to several Indigenous communities who have maintained a traditional lifestyle in harmony with the forest. However, the expansion of soybean production and deforestation in this region has changed the relationship between such communities and the land, triggering resistance movements in these populations.[54] Since the early 2000s, South American Indigenous communities, such as the Kaingang in Brazil, began to demand the demarcation of more Indigenous lands by claiming their traditional rights in the face of the large-scale soybean monocultures threatening their existence, with their demands occasionally resulting in violent confrontations and deaths.[55]

Therefore, the soybean trade has not only promoted the expansion of land use in South America but has also brought a series of significant impacts on the socio-economic and environmental conditions of importing and exporting countries. This shows the formation of a telecoupling land-use system between South American countries and their soybean trade partners.

2.3. Telecoupling Framework related to Soybean Land Use in South America

The framework of telecoupling was introduced by Liu and co-authors in 2013 to explain the relationship between interaction factors in distant places.[56] The framework divides the telecoupling system into five major components: system, flow, agent, cause, and effect (see Table 1).[57] Although the telecoupling framework has been criticized for insufficient analyses of causal attribution,[58] it demonstrates the interaction mechanisms of telecoupling systems and, thus, provides a useful tool for the analysis of a telecoupled land-use system.

In the telecoupling system between South American countries and their main soybean trade partners, soybean land-use systems in South American countries, such as Brazil, make up the sending system, and the social ecosystems related to soybean imports in soybean-importing countries, such as China, make up the receiving system.[59] The causes for the generation of this telecoupling system can be attributed,

[52] D.F. Amaral et al., 'Expansion of Soybean Farming into Deforested Areas in the Amazon Biome: The Role and Impact of the Soy Moratorium' (2021) 16(4) *Sustainability Science*, pp. 1295–312, at 1296.

[53] L.E. Andersen et al., *The Dynamics of Deforestation and Economic Growth in the Brazilian Amazon* (Cambridge University Press, 2002), p. 5.

[54] R. Walker & C. Simmons, 'Endangered Amazon: An Indigenous Tribe Fights Back Against Hydropower Development in the Tapajós Valley' (2018) 60(2) *Environment: Science and Policy for Sustainable Development*, pp. 4–15, at 8–9.

[55] D. Barbosa, E. Oderich & A. Camana, 'Kaingang Indigenous Family Farmers and Soy in Southern Brazil: New Old Conflicts over Land' (2022) 50(1) *Oxford Development Studies*, pp. 30–43.

[56] Liu et al., n. 17 above.

[57] Ibid.

[58] A.K. Carlson et al., 'Toward Rigorous Telecoupling Causal Attribution: A Systematic Review and Typology' (2018) 10(12) *Sustainability*, article 4426, p. 2.

[59] R.F.B. da Silva et al., 'The Sino-South American Telecoupled Soybean System and Cascading Effects for the Exporting Country' (2017) 6(3) *Land*, article 53, p. 3.

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Table 1. A Telecoupling Framework for a Soybean Land-Use System in South America

Systems	Sending	Soybean cultivation land-use system in South American countries
	Receiving	Social ecosystem related to soybean imports in China, France, Germany, and other countries importing South American soybeans
Flows	Material	Soybeans
		Alien species related with soybean trade
		Glyphosate residues
		Nitrogen, phosphorus, and other related material
	Money	US dollar (US$)
		Renminbi (RMB) and other related currency
	Information	Price information
		Market supply and demand information
		Information on deforestation in the Amazon
		Trade policies and other related information
	Personnel	Soybean traders, soybean shipper, heads of state and government, other related personnel
Agents	State	Brazil, Argentina, and other South American soybean producing countries
		China
		France, Germany, and other South American soybean importing countries
	Supranational organizations	European Union (EU)
	Non-state actors	Greenpeace
		Round Table on Responsible Soy (RTRS)
		China Oil and Foodstuffs Corporation (COFCO) and other related non-state actors
Causes	Economic	Factory farm boom
		Trade liberalization of soybean production
		Low cost of soybean production in South America and other related economic issues
	Technological	Introduction of soybean varieties to South American countries
		Soil improvement in Brazil
		Improvements in soybean breeding and cultivation technology in South American countries, and other related technology
	Environmental	Pressure for environmental protection and shortage of agricultural resources in importing countries
		Rich natural resources in South American countries and other related environmental factors
Effects	Economic	Increase in soybean trade
		Increase in employment
		Factory farm development and other related economic effects

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Society	Intensive land use in South America
	Increased consumption of meat and milk
	Impacts on the rights of Indigenous peoples
	Food security in importing countries and other related society effects
Environmental	Deforestation in South American soybean-producing countries
	Loss of biodiversity in South American soybean-producing countries
	Disruption of nitrogen and phosphorus cycles of the Earth system
	Glyphosate residues in transnational supply chain and other related environmental effects

among others, to the emergence of intensive animal farming, the liberalization of the soybean market, a shortage of farmland and water in importing countries, and the low cost of soybean production in South America. Flows in the telecoupling system include but are not limited to the transnational exchanges of soybeans, US dollars, Chinese yuan, chemical fertilizers, and market information related to soybean production and trade. The agents of the telecoupling system include the involved states (such as Brazil, Argentina, and China), non-governmental organizations (such as Greenpeace), and supranational organizations (such as the EU). The effects of the interaction between distance factors in the telecoupling system have both positive and negative consequences, which were analyzed in the subsection above.

3. Existing Transnational Governance of Soybean Land Use in South America

3.1. Governance at the Traditional International Law Level

The traditional international law system is founded on the doctrine of territorial sovereignty,[60] under which states cannot directly exercise jurisdiction over activities within the territory of other states. Therefore, it is difficult for the traditional international governance paradigm to address the telecoupled land-use systems. Nevertheless, existing multilateral international law provides the basic legal framework for the sustainable governance of soybean land use in South America.

As the main soybean-exporting countries in South America (for example, Brazil and Argentina) are all signatories to a series of important environmental conventions – such as the Convention on Biological Diversity (CBD)[61] and the United Nations Framework Convention on Climate Change (UNFCCC)[62] – they are obliged to meet the commitments of these conventions. However, as very few treaty regimes concerning environmental protection have set up credible international enforcement structures

[60] A. Osiander, 'Sovereignty, International Relations, and the Westphalian Myth' (2001) 55(2)*International Organization*, pp. 251–87.
[61] Rio de Janeiro (Brazil), 5 June 1992, in force 29 Dec. 1993, available at: http://www.cbd.int/convention.
[62] New York, NY (US), 9 May 1992, in force 21 Mar. 1994, available at: https://unfccc.int.

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and systems in practice,[63] challenges are faced when trying to effectively resolve the unsustainable land-use problems caused by soybean expansion in South America through multilateral environmental treaties.

As opposed to multilateral environmental agreements, the World Trade Organization (WTO) dispute settlement mechanism compels the enforcement of multilateral trade rules. However, environmental protection is just an exception stipulated in Article XX GATT 1994.[64] In accordance with the principle of non-discrimination, WTO members may not differentiate between commodities according to production and processing methods. Thus, environmental costs (such as deforestation, soil degradation, and pesticide pollution) are generally excluded from market prices under the WTO system. Therefore, WTO rules fail to represent an international legal system that is conducive to ecological justice and are unable to achieve effective governance of soybean land use in South America.

Nevertheless, the Amsterdam Declaration towards Eliminating Deforestation from Agricultural Commodity Chains with European Countries (Amsterdam Declaration)[65] (signed in 2015 by seven European countries, including Denmark, France, Germany, the Netherlands, and the United Kingdom), and the Europe Soya Declaration, initiated in 2013 (signed jointly by 24 European countries),[66] provide a new basis in international law for the governance of South American soybean land use. The Amsterdam Declaration promotes the goal of zero deforestation and, in particular, the commitments expressed in the United Nations (UN) New York Declaration on Forests,[67] underlining the global importance of preserving primary forests and high-value conservation areas through responsible supply chain management.[68] The Europe Soya Declaration aims to boost soybean cultivation in Europe, bringing it even closer to reaching the UN Sustainable Development Goals (SDGs),[69] especially with regard to improving the world's food supply and using natural resources sustainably.[70] However, these international documents can bind only European signatories and have little direct influence on soybean land use in South America.

3.2. Unilateral Governance by European Countries

The large European import of soybeans stems from the rise of confined animal feeding operations (CAFOs) or factory farms since the 1960s, which dramatically increased the

[63] M. Hedemann-Robinson, *Enforcement of International Environmental Law: Challenges and Responses at the International Level* (Routledge, 2018), p. 3.

[64] Marrakesh (Morocco), 15 Apr. 1994, in force 1 Jan. 1995, available at: http://www.wto.org/english/docs_e/legal_e/06-gatt_e.htm.

[65] Amsterdam (The Netherlands), 7 Dec. 2015, available at: https://ad-partnership.org/wp-content/uploads/2018/10/Amsterdam-Declaration-Deforestation-Palm-Oil-v2017-0612.pdf.

[66] Brussels (Belgium), 17 July 2017, available at: https://www.donausoja.org/wp-content/uploads/2022/01/joined-declaration.pdf.

[67] New York, NY(US), 23 Sept. 2014, available at: https://forestdeclaration.org.

[68] Amsterdam Declaration, n. 65 above, Preamble and para. 1.

[69] UN General Assembly Resolution 70/1, 'Transforming Our World: The 2030 Agenda for Sustainable Development', 25 Sept. 2015, UN Doc. A/RES/70/1, available at: https://sdgs.un.org/2030agenda.

[70] Europe Soya Declaration, n. 66 above.

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demand for pig and chicken feed made from soybeans.[71] To meet this demand, European countries prioritized international trade over self-sufficiency, since soybean as an ingredient of animal feed is less important than crops, milk, and meat for human food. However, after decades of this practice, Europeans realized that the idea of developing factory farming methods using imported soybeans not only disrupted the nutrient balance between horticulture and animal husbandry in Europe – leading to a series of environmental and ethical problems such as serious animal suffering,[72] antibiotics residue,[73] and agricultural pollution[74] – but also provided a strong driving force for deforestation in South America.[75] Therefore, starting from the late 20th century, the EU has begun to rethink this agricultural model and encourage local soybean production through various methods to promote the sustainable development of agriculture in Europe and to reduce the negative impact of imported soybeans on land-use systems in South America, simultaneously.

Europe has a large amount of land suitable for soybean cultivation, especially in the Danube River Basin; however, soybean production in Europe has long been low because of Europe's free-trade policies regarding soybeans, such as a zero tariff for the product.[76] To reverse this adverse situation, the Danube Soybean Association was founded in 2012, and the Danube Soybean Initiative was launched to promote non-genetically modified organism (non-GMO) soybean production in the region.[77] These measures aim to expand the use of soybeans as not just animal feed but also a protein supplement for human beings. The specific goals are to boost value in the rural economies; promote European cooperation with and economic integration of the surplus areas of Central and Eastern Europe; improve crop rotation; reduce nitrogen fertilizer use; increase food security; and offer safe, reliable, constant, and sustainable European protein to soybean users and consumers across Europe.[78]

In addition to the Danube Soybean Association and the Danube Soybean Initiative, the EU has also played an important role in promoting soybean production in the region. Since the Common Agricultural Policy (CAP) reforms of 2013,[79] the EU has authorized its Member States to subsidize the production of plant proteins to protect

[71] Abel, n. 8 above.
[72] R. Harrison, *Animal Machines* (Vincent Stuart, 1964), pp. 1–179.
[73] D.A. Franco, J. Webb & C.E. Taylor, 'Antibiotic and Sulfonamide Residues in Meat: Implications for Human Health' (1990) 53(2) *Journal of Food Protection*, pp. 178–85, at 178.
[74] T.L.V. Ulbricht, 'Agriculture and Pollution' (1980) 5(1) *Food Policy*, pp. 72–3.
[75] K. Khatun, 'Reform or Reversal: Implications of the Common Agricultural Policy (CAP) on Land Use, Land Use Change, and Forestry (LULUCF) in Developing Countries' (2012) 5(2) *Conservation Letters*, pp. 99–106, at 102.
[76] Regulation (EEC) No. 2658/87 on the Tariff and Statistical Nomenclature and the Common Customs Tariff [1987] OJ L 256/1.
[77] Donau Soja, available at: https://www.donausoja.org/organisation.
[78] M. Krön & U. Bittner, 'Danube Soya: Improving European GM-Free Soya Supply for Food and Feed' (2015) 22(5) *Oilseeds and Fats, Crops and Lipids*, article D509, p. 2.
[79] See European Commission, 'The Common Agricultural Policy at a Glance', available at: https://agriculture.ec.europa.eu/common-agricultural-policy/cap-overview/cap-glance_en.

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biodiversity and mitigate climate change;[80] soybeans are an important target of these subsidies. The idea to support the production of plant proteins for sustainable development in the EU was maintained after the CAP reform of 2021.[81] The EU hopes to reduce soybean imports from South America, thereby reducing the driving force for soybean expansion in South America through these efforts.[82]

Furthermore, to strengthen the sustainable governance of transnational soybean supply chains, some EU Member States have passed laws to prevent the importation into the European market of soybeans produced in unsustainable ways. In 2021, for example, Germany passed a supply chain law that requires companies to conduct due diligence in respect of potential human rights violations and certain environmental risks in their supply chains.[83] In the EU, Regulation (EU) 2023/1115 on deforestation-free products, adopted in May 2023, requires companies to meet certain standards to conduct due diligence on deforestation in their supply chain.[84] On 24 April 2024, the EU adopted its new Corporate Sustainability Due Diligence Directive (CSDDD).[85] The new rules seek to ensure that (large) companies identify and address adverse human rights and environmental impacts of their activities inside and outside Europe. These laws are conducive to ensuring that soybeans exported to the European market are produced sustainably and indirectly promote sustainable soybean land use in South American countries.

3.3. Governance by Non-State Actors

Over the past two decades, the development of transnational supply chains for agricultural products has greatly changed the global governance system for arable land use. Non-state actors have taken on governance functions in existing policy fields through modes of self-regulation,[86] which has resulted in a reconfiguration of political power, rendering the state no longer the predominant actor in transnational

[80] A. Bues et al., 'The Environmental Role of Protein Crops in the New Common Agricultural Policy', Study commissioned by the European Parliament, May 2013, available at: https://www.europarl.europa.eu/RegData/etudes/etudes/join/2013/495856/IPOL-AGRI_ET(2013)495856_EN.pdf.

[81] European Parliament, 'Resolution on European Protein Strategy', 2023/2015(INI), 19 Oct. 2023, available at: https://www.europarl.europa.eu/doceo/document/TA-9-2023-0375_EN.html.

[82] European Parliament, 'Report on a European Strategy for the Promotion of Protein Crops: Encouraging the Production of Protein and Leguminous Plants in the European Agriculture Sector', Report A8-0121/2018, 27 Mar. 2018, available at: https://www.europarl.europa.eu/doceo/document/A-8-2018-0121_EN.html.

[83] Act on Corporate Due Diligence Obligations for the Prevention of Human Rights Violations in Supply Chains (Lieferkettensorgfaltspflichtengezetz), 16 July 2021, available at: https://www.csr-in-deutschland.de/SharedDocs/Downloads/EN/act-corporate-due-diligence-obligations-supply-chains.pdf?__blob=publicationFile#linkicon.

[84] Regulation (EU) 2023/1115 on the Making Available on the Union Market and the Export from the Union of Certain Commodities and Products Associated with Deforestation and Forest Degradation and Repealing Regulation (EU) No 995/2010 [2023] OJ L 150/206.

[85] Directive (EU) 2024/1760 on Corporate Sustainability Due Diligence and Amending Directive (EU) 2019/1937 and Regulation (EU) 2023/2859 [2024] OJ L, 2024/1760.

[86] M.E. Margulis, N. McKeon & S.M. Borras Jr., 'Land Grabbing and Global Governance: Critical Perspectives' (2013) 10(1) *Globalizations*, pp. 1–23, at 9.

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governance.[87] The rise of governance by non-state actors is closely linked to the implementation of neoliberal policies, such as privatization and deregulation. Soybeans are a highly liberalized commodity in the world trade system, providing rich opportunities for non-state actors to participate in transnational governance.

Since the beginning of the 21st century, with the continuous expansion of soybean cultivation in the Amazon, deforestation has become a major concern for the transnational governance of soybean land use in South America. In response to pressure from retailers and non-governmental organizations (NGOs), in July 2006 (and renewed every year since), major soybean traders signed the Amazon Soybean Moratorium,[88] whereby they agreed not to purchase soybeans grown on lands deforested after July 2006 in the Brazilian Amazon.[89] This was implemented by major soybean producers and traders in Brazil, including companies affiliated with the Brazilian Association of Vegetable Oil Industries (ABIOVE) and the National Association of Grain Exporters (ANEC).[90] The state-owned China Oil and Foodstuffs Corporation (COFCO), the largest soybean trader in China, has also joined the Amazon Soybean Moratorium.[91]

Private voluntary standards and certifications are another important way for non-state actors to engage in transnational governance for sustainable land use in South America. These include the Round Table on Responsible Soy (RTRS) Standard for Responsible Soy Production,[92] Forest-Friendly Soy Pilot Project,[93] and the soybeans sourcing guidelines of the European Feed Manufacturers' Federation (FEFAC).[94] These voluntary standards present rich content, including respect for basic human rights, worker health and safety, the environmental impacts of production, and community relations. Most of these non-state actors using such voluntary standards are from Europe, reflecting the main concerns of the European market regarding sustainable soybean land use in South America. However, they are usually not widely accepted by South American soybean producers because of a lack of adequate negotiations with them.

3.4. Effect of Existing Governance Measures

Over the past two decades, various transnational governance measures have been developed for the governance of soybean land use in South America. However, they

[87] V. Higgins & G. Lawrence, *Agricultural Governance: Globalization and the New Politics of Regulation* (Routledge, 2005), p. 1.

[88] Available at: https://www.fairr.org/investor-statements/amazon-soy.

[89] H.K. Gibbs et al., 'Brazil's Soy Moratorium: Supply-Chain Governance is Needed to Avoid Deforestation' (2015) 347(6220) *Science*, pp. 377–8.

[90] Amaral et al., n. 52 above.

[91] COFCO International, 'Collective Action in Brazil', available at: https://www.cofcointernational.com/sustainability/connecting-supply-and-demand-responsibly/soybean.

[92] J.I. Staricco, 'The Round Table on Responsible Soy's Landnahme: Converting Sustainable Practices into Tradable Intangibles to Protect the Environment' (2020) 14(5) *Journal of Cultural Economy*, pp. 564–79.

[93] F. Jia et al., 'Soybean Supply Chain Management and Sustainability: A Systematic Literature Review' (2020) 255 *Journal of Cleaner Production*, article 120254, p. 10.

[94] L. Fernandez, 'FEFAC Guidelines Stress Responsible Soy Imports to EU' (2016) 37(3) *Feed International*, pp. 14–6.

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have not been completely successful in resolving the resultant unsustainable problems as a whole.

The Amsterdam Declaration and the Europe Soya Declaration demonstrate the determination of European countries to promote sustainable soybean production, providing a strong base for reform of the EU agricultural production paradigm. Owing to the new agricultural policies and incentive measures, European soybean production has developed significantly over the past 20 years. According to FAO statistics, the harvest area of soybeans in Europe increased six-fold between 2000 and 2022, from 1.04 million ha to 6.26 million ha.[95] Notwithstanding, Europe has not substantially reduced its soybean imports in tandem with the increase in the soybean harvest area. FAO statistics show that Europe imported 16.43 million tonnes of soybeans in 2013 and 19.72 million tonnes in 2022, an increase of 3.29 million tonnes.[96] One reason for this increase in imports is that the soybeans produced in European countries are non-GMO, intended mostly for human consumption, while imported GMO soybeans from South America are generally used for animal feed.

The Amazon Soybean Moratorium has played a certain role in the decline of deforestation in the region. After the Soybean Moratorium, deforestation for soybeans decreased dramatically, falling to only 1% of expansion in the Amazon biome by 2014;[97] however, deforestation in the Amazon increased rapidly after 2014.[98] According to the Brazilian National Institute for Space Research (INPE), deforestation in the Amazon region covered an area of 11,594 km^2 in 2022, more than double that of 2014.[99] Further, the Amazon Soybean Moratorium has led the expansion of soybean production in South America to move to the less-regulated Cerrado region, which in turn brings risks associated with an accelerated conversion of native vegetation in the Cerrado biosphere.[100] Therefore, the effect of the Amazon Soybean Moratorium on deforestation has been overestimated.[101]

Nor has the problem of chemical abuse been effectively addressed either. Although the voluntary standards developed by non-state actors have created rules to reduce the use of agricultural chemicals, they do not strictly regulate them; nor do they prohibit the use of glyphosate and chemical fertilizer in general. The unilateral governance of supply chain law by European countries is focused mainly on deforestation and labour rights, and leaves great discretion for exporting countries on how to use agricultural chemicals. In fact, soybean production in South America still involves a large amount

[95] FAO, n. 2 above.
[96] Ibid.
[97] Gibbs et al., n. 89 above.
[98] F. Gollnow et al., 'Scenarios of Land-Use Change in a Deforestation Corridor in the Brazilian Amazon: Combining Two Scales of Analysis' (2018) 18 *Regional Environmental Change*, pp. 143–59.
[99] INPE, 'Incrementos de desmatamento – Amazonia Legal – Estados', available at: https://terrabrasilis.dpi.inpe.br/app/dashboard/deforestation/biomes/legal_amazon/increments.
[100] A.C. Soterroni et al., 'Expanding the Soy Moratorium to Brazil's Cerrado' (2019) 5(7) *Science Advances*, article eaav7336, p. 1.
[101] T. Harding, J. Herzberg & K. Kuralbayeva, 'Commodity Prices and Robust Environmental Regulation: Evidence from Deforestation in Brazil' (2021) 108 *Journal of Environmental Economics and Management*, article 102452.

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of agricultural chemicals as the large-scale cultivation of GMO soybeans based on a monoculture technical system remains dominant in this region; this is associated with a reduction in agricultural diversity and a loss in the amount, variety, and spatial and temporal availability of floral resources.[102] FAO statistics reveal that the use of agricultural chemicals in South America did not markedly decrease over the past two decades, but instead showed a clear upward trend. The agricultural use of pesticides in South America increased from 342,100 tonnes in 2000 to 1.11 million tonnes in 2021, and the agricultural use of phosphate fertilizer in the region increased from 3.2 million tonnes in 2000 to 8.4 million tonnes in 2021.[103]

Land tenure disputes related to soybean production in South America still exist, especially in the Amazon region. A large area of Indigenous land has not been demarcated in this region, which has become a source of land tenure conflict.[104] The lack of a guarantee of land rights is also one of the main causes of violations of the rights of Indigenous peoples.[105] In 2012, Brazil's new Forest Code[106] created a Rural Environmental Registry (Cadastro Ambiental Rural (CAR) in South American Portuguese) to register rural properties, but registration in the CAR is not equivalent to a land title, and indeed does not indicate anything about legal ownership; overlapping claims are allowed in the CAR system.[107] However, as the new Forest Code grants amnesty for illegal deforestation in 90% of Brazilian rural properties,[108] the original illegal land tenure has gained legal status, covering up the land tenure dispute in soybean production.

3.5. Dysfunction of Existing Transnational Governance Systems

As the above analysis clarifies, the existing transnational governance system has not achieved its goal of effective governance of soybean land-use systems in South America. The main reason for this is deeply rooted in the inherent disadvantages of traditional international governance paradigms dominated by sovereign states, which led to the fragmentation of the governance system and the failure to consider the interactive factors in distant places within the governance system.

Under the Westphalian system, sovereignty has become the cornerstone of the international governance system, with states enjoying supreme jurisdiction over activities within their territories. The territorial sovereignty of states is still a core pillar

[102] G.S. de Groot et al., 'Large-Scale Monoculture Reduces Honey Yield: The Case of Soybean Expansion in Argentina' (2021) 306 *Agriculture, Ecosystems & Environment*, article 107203.
[103] FAO, n. 2 above.
[104] Barbosa, Oderich & Camana, n. 55 above.
[105] G.F. Monteiro et al., 'Indigenous Land Demarcation Conflicts in Brazil: Has the Supreme Court's Decision Brought (In)stability?' (2019) 48(2) *European Journal of Law and Economics*, pp. 267–90.
[106] Lei No. 12.651, 25 May 2012, available at: https://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm.
[107] S. Jung et al., 'Brazil's National Environmental Registry of Rural Properties: Implications for Livelihoods' (2017) 136(1) *Ecological Economics*, pp. 53–61.
[108] D. Arvor et al., 'Combining Socioeconomic Development with Environmental Governance in the Brazilian Amazon: The Mato Grosso Agricultural Frontier at a Tipping Point' (2018) 20(1) *Environment, Development and Sustainability*, pp. 1–22, at 11.

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of international law systems.[109] In this paradigm of international governance based on sovereignty, the holistic earth system is arbitrarily divided into more than 190 independent states under existing international law. Meanwhile, influenced by the mechanistic paradigm of modern Western thinking, existing international laws adopt a reductionist notion of justice[110] and artificially divide the coupled nature–human system into several separate fields – such as environment, human rights, and trade – which also impedes an integrated governance approach. All these inherent shortcomings lead to a fragmented governance system, rendering it difficult to adopt factors that interact between distant places into such a governance paradigm.

Soybeans are a crucial international commodity for trade in South America. Instead of being grown for domestic consumption, most South American soybeans are exported as feed raw materials. As soybean land use in South America is highly influenced by the international consumer market for animal feed, a telecoupled land-use system between South American countries and their soybean-importing partners has been formed. In this telecoupled system, the causes of soybean land use and the environmental consequences of soybean production occur spatially separately and bring to the fore new challenges for the current state-dominated international governance, as the interaction factors in distant places are not the main concern of this governance system.

The participation of non-state actors in governance can help to overcome the spatial disconnect problem in the existing governance system, but it does not constitute a complete solution; voluntary standards are not democratically legitimate in the sense that members are not publicly elected officials.[111] Owing to a lack of coordination with each other, the content of these voluntary standards often replicates and embodies biases and power imbalances, and implementation audits often rely on self-reporting. The divergence of the economic interests of non-state actors results in different voluntary regulations that compete with or duplicate each other, which further exacerbates the fragmentation of the existing governance system. As a voluntary measure, the intense market competition between different standards usually triggers a 'race to the bottom' between standards,[112] further damaging their implementation effect. In addition, voluntary regulations set by non-state actors cannot surpass the influence of a country's basic political and economic systems and cannot automatically resolve issues related to public policies, such as food sovereignty and family farms. 'Bypassing the state' has turned out to be nearly impossible.[113] For these reasons, the

[109] N. Krisch, 'Jurisdiction Unbound: (Extra)territorial Regulation as Global Governance' (2022) 33(2) *European Journal of International Law*, pp. 481–514.

[110] K. Pope, M. Bonatti & S. Sieber, 'The What, Who and How of Socio-ecological Justice: Tailoring a New Justice Model for Earth System Law' (2021) 10 *Earth System Governance*, article 100124, p. 1.

[111] R.D. Garrett et al., 'Assessing the Potential Additionality of Certification by the Round Table on Responsible Soybeans and the Roundtable on Sustainable Palm Oil' (2016) 11(4) *Environmental Research Letters*, article 045003, p. 2.

[112] A. Thiel & C. Moser, 'Toward Comparative Institutional Analysis of Polycentric Social-Ecological Systems Governance' (2018) 28(4) *Environmental Policy and Governance*, pp. 269–83, at 275.

[113] T. Bartley, 'Transnational Governance and the Re-centered State: Sustainability or Legality?' (2014) 8(1) *Regulation & Governance*, pp. 93–109.

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voluntary standards of non-state actors are often described as an act of greenwashing or self-promotion, and are usually accepted with a limited scope.[114]

Unilateral governance by the EU as a key consumer market for South American soybeans can be viewed as another response to this spatial challenge; however, owing to the obstacle of national sovereignty this unilateral approach also cannot provide a comprehensive solution for the governance of distance factors. Furthermore, the role of China and Brazil in the governance is not fully considered and there is a mismatch with their status as the two main soybean-trading countries in the world. As a state with more than 1.4 billion people, China relies heavily on imports to ensure domestic food security, which impedes its interests in sustainable soybean commitments. Meanwhile, China also faces obstacles related to traceability and higher costs for purchasing sustainable soybeans than regular soybeans.[115]

In sum, the existing international governance system lacks a comprehensive design for the integrated governance of interaction factors in distant places. The dispersive components in the existing transnational governance system eventually render the whole governance mechanism fragmented and dysfunctional. Therefore, to achieve effective governance of soybean land use in South America, a new paradigm is needed for the existing transnational governance system.

4. Polycentric Governance of the Telecoupled Soybean Land-Use System in South America

4.1. Emergence of a Polycentric Approach in Transnational Land-Use System Governance

The concept of polycentricity was first envisaged by Polanyi in his book *The Logic of Liberty*.[116] In 1961, Ostrom, Tiebout and Warren first applied the concept of polycentricity to governance literature; they defined it as different decision-making centres that are formally independent of each other might take each other into account in competitive relationships and create effective governance arrangements.[117] Polycentric governance is thought to improve the spatial fit between knowledge, action, and socio-ecological contexts to ensure that governance responses are implemented on the most appropriate scale.[118] Compared with the traditional top-down centralized governance paradigm, polycentric governance is conducive to realizing the governance

[114] L. Gatti, P. Seele & L. Rademacher, 'Grey Zone In – Greenwash Out: A Review of Greenwashing Research and Implications for the Voluntary-Mandatory Transition of CSR' (2019) 4 *International Journal of Corporate Social Responsibility*, article 6.

[115] L.S. Nepstad et al., 'Pathways for Recent Cerrado Soybean Expansion: Extending the Soy Moratorium and Implementing Integrated Crop Livestock Systems with Soybeans' (2019) 14(4) *Environmental Research Letters*, article 044029.

[116] M. Polanyi, *The Logic of Liberty* (Routledge, 1951). See also P.D. Aligica & V. Tarko, 'Polycentricity: From Polanyi to Ostrom, and Beyond' (2012) 25(2) *Governance*, pp. 237–62.

[117] V. Ostrom, C.M. Tiebout & R. Warren, 'The Organization of Government in Metropolitan Areas: A Theoretical Enquiry' (1961) 55(4) *American Political Science Review*, pp. 831–42.

[118] Cvitanovic et al., n. 24 above.

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of social ecosystems across multiple jurisdictions and has been regarded as a potential solution for analyzing the complex environmental problems.[119]

To support sustainable land-use governance in telecoupling systems, Oberlack and co-authors combined the concepts of telecoupling systems theory with the polycentric governance theory developed by Ostrom and her colleagues within the Institutional Analysis and Development framework, and proposed a polycentric governance approach for telecoupled resource systems. Accordingly, they provided a way to link place-based land-use analysis with process-based land-use analysis across multiple jurisdictions. The main advantage of the polycentric governance approach for telecoupled land-use systems is with regard to expanding the scope of governance from small-scale to larger-scale resource systems, partly shifting land governance from state-based to flow-centred arrangements.[120]

In practice, the transnational governance of sustainable biofuels in the EU provides an example of polycentric governance of a telecoupled land-use system. The 2018 EU Renewable Energy Directive (RED),[121] together with its associated decisions, regulations, norms, and standards, lay the groundwork for a novel governance approach to biofuels within the EU, wherein the EU sets a 'meta-standard' and leaves it to private initiatives to assess and certify compliance through private certification schemes.[122] Through this approach, the EU creates a polycentric governance landscape within the EU biofuel market. Although there are ethical concerns related to the food security *versus* fuel debate and other complex discussions in this context,[123] it provides a good reference for the polycentric governance of telecoupled land-use systems.

4.2. Gap Between the Existing Transnational Governance System and Polycentric Governance

Not all governance systems with multiple decision-making centres should be characterized as a polycentric governance system; such systems have three attributes. First and foremost, polycentricity requires the existence of many centres of decision making that are formally independent of each other; the second attribute involves continued competition, cooperation, and conflict resolution between the centres of decision making; the third attribute requires the presence of an overarching shared system of rules.[124] Therefore, polycentric governance is different from polycentric chaos or anarchism. Determining whether a governance system with multiple decision-making centres is a

[119] L. Acton, R.L. Gruby & A. Nakachi, 'Does Polycentricity Fit? Linking Social Fit with Polycentric Governance in a Large-Scale Marine Protected Area' (2021) 290 *Journal of Environmental Management*, article 112613.

[120] Oberlack et al., n. 23 above, p. 2.

[121] Directive (EU) 2018/2001 on the Promotion of the Use of Energy from Renewable Sources (recast) [2018] OJ L 328/82.

[122] S.L. Stattman et al., 'Toward Sustainable Biofuels in the European Union? Lessons from a Decade of Hybrid Biofuel Governance' (2018) 10(11) *Sustainability*, article 4111.

[123] A. Albatayneh, 'The Energy-Food Dilemma for Utilizing Biofuels in Low-Income Communities Amidst the Russian–Ukrainian Conflict' (2023) 41(6) *Energy Exploration & Exploitation*, pp. 1942–55.

[124] J. van Zeben & A. Bobić, *Polycentricity in the European Union* (Cambridge University Press, 2019), pp. 23–4.

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polycentric governance system requires an in-depth diagnosis. This study further compares existing transnational governance with the attributes of polycentric governance systems and analyzes whether the existing governance system is of a polycentric nature.

Currently, several independent decision-making centres are involved in the transnational governance of soybean land use in South America, which include state and non-state actors. Among them, governance by state actors stems mainly from European countries. They signed the Europe Soya Declaration,[125] strengthening domestic soybean production and developing sustainable supply chain laws to prevent the importation of South American deforestation soybeans. The EU also plays an important role in governance through reform of the CAP and the encouragement of plant protein crops by agricultural subsidies. Centres for non-state actors include the ProTerra Foundation, Greenpeace, and the RTRS. The main functions of non-state actors are to set voluntary sustainable soybean standards and put forward the Amazon Soybean Moratorium. China and Brazil, the two largest traders in South American soybeans, have also participated in governance to a certain extent. For example, COFCO has committed to support the sustainable and responsible production and sourcing of soybeans, aiming for full traceability for direct purchases of soybeans from Brazil,[126] and Brazilian non-state actors enacted the Soja Plus programme in 2011.[127]

Although many decision-making centres are involved in governance, no clear division of labour exists among them, and most actors operate independently without coordination with each other. EU Member States are a notable exception in that they undertake a legal obligation stemming from the EU treaties in the governance system. However, an orderly and functionally integrated governance system has not yet been formed in the entire telecoupling system. It is easy to encounter inefficient overlaps within the existing governance system. For example, governance by both state and non-state actors includes the prevention of deforestation in the Amazon; however, no substantive cooperation mechanism exists between them with regard to mutual support and collaboration to achieve effective governance of deforestation in the Amazon. There is also significant duplication in the various voluntary standards of the non-state actors, as most of them cover issues such as sustainable cultivation technology, labour standards, and reducing the use of agricultural chemicals. However, details of these standards are usually determined separately by each non-state actor based on their own decision making, resulting in significant divergences on what constitutes sustainable soybean land use.

[125] Europe Soya Declaration, n. 66 above.

[126] COFCO, 'The Importance of Tracing the Supply Chain', 3 June 2022, available at: https://www.cofcointernational.com/newsroom/the-importance-of-tracing-the-supply-chain. See also K.W. Bowman et al., 'Environmental Degradation of Indigenous Protected Areas of the Amazon as a Slow Onset' (2021) 50 *Current Opinion in Environmental Sustainability*, pp. 260–71, at 264.

[127] Cultivar, 'Goiás is the Fifth State to Join Soja Plus', 27 Nov. 2017, available at: https://revistacultivar.com/noticias/goias-e-o-quinto-estado-a-aderir-ao-soja-plus. See also Lima et al., n. 10 above.

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A further issue brought about by the lack of coordination concerns conflict in the governance system. For example, conflicts over the design of standards and the programme's objectives between soybean producers and traders in Brazil and the RTRS have caused ABIOVE and Aprosoja to pull out of the RTRS before the standard was finalized,[128] and the enactment of the Soja Plus programme – a new sustainable management programme for rural properties to train soybean producers in the several stages of socio-environmental adaptation.[129] Furthermore, owing to the lack of a dispute settlement mechanism, conflict among different centres is usually resolved through diplomacy, which may seriously harm international relations between South American countries and their soybean-importing partners. In December 2020, for example, France's harsh criticism of Amazon deforestation devolved into a political dispute with the Brazilian government.[130]

Therefore, although there are multiple independent decision-making centres in the existing transnational governance system, their roles in general are not well integrated and designed. No clear division of labour or collaboration arrangements exist among them. From a larger scale of telecoupling, the existing governance system cannot be regarded as a real polycentric governance system; rather, it is just polycentric chaos without order. To become a real polycentric governance system, it still needs to undergo a series of comprehensive reforms.

4.3. Improving Existing Transnational Governance of the Land-Use System in South America: A Polycentric Approach

The following suggestions are proposed to promote the polycentric governance of telecoupled soybean land use in South America.

Increased involvement of major governance centres

Currently, the centres that participate in the transnational governance of soybean land use in South America are mainly state and non-state actors from Europe, such as the EU, Greenpeace, and the RTRS. China and Brazil, the two main soybean traders, have not played a critical role in governance, from the perspective of both state and non-state actors, which does not match their position as the world's largest soybean-trading countries and highlights an obvious vulnerability in the governance system.

Soybeans originated in China, which was once the largest exporter of soybeans in history. Today, with the development of China's economy, more soybean is consumed in China than in any other place in the world, and in higher volumes than at any other

[128] P. Schleifer, 'Private Regulation and Global Economic Change: The Drivers of Sustainable Agriculture in Brazil' (2017) 30(4) *Governance*, pp. 687–703, at 689–92.

[129] Cultivar, n. 127 above. See also O. Hospes, 'Marking the Success or End of Global Multi-Stakeholder Governance? The Rise of National Sustainability Standards in Indonesia and Brazil for Palm Oil and Soy' (2014) 31 *Agriculture and Human Values*, pp. 425–37.

[130] M. Sotirov et al., 'Policy Options to Regulate Timber and Agricultural Supply-Chains for Legality and Sustainability: The Case of the EU and Brazil' (2022) 144 *Forest Policy and Economics*, article 102818, p. 6.

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time in history.[131] Trade has become an important instrument for China to meet its huge demand for soybeans. However, the participation of Chinese actors in governance is still relatively low. The Chinese government has not enacted any supply chain laws and cannot use hard laws to govern its soybean supply chain and prevent unsustainably produced soybeans from being imported into Chinese markets. Although the Chinese government has implemented a soybean revitalization plan to reduce the importation of soybeans in recent years, the main purpose of this plan is to ensure domestic food security; sustainable soybean land use in South American countries is not its main concern. The participation of Chinese non-state actors in governance is not high either. COFCO has pledged to participate in a tracing programme for its soybean imports to counteract the use of illegal land in Brazil for soybean farming.[132] However, with the exception of COFCO, only a few other Chinese non-state actors are actively involved in sustainable soybean governance. Meanwhile, Chinese non-state actors have not fully utilized the voluntary standards. Currently, they have neither introduced their own sustainable soybean standards nor participated in the existing standards of other non-state actors, which further limits their role in governance.

Insufficient governance by Chinese actors indirectly reduces the effectiveness of governance by European countries and the participation of Brazilian actors in governance, as Brazilian soybean producers can easily circumvent the stricter governance requirements of other actors by exporting soybeans to the Chinese market. Apart from divergences in the content of sustainable standards, a shift in end markets from the EU to China was another important factor underlying the change in position of Aprosoja and ABIOVE vis-à-vis the RTRS. As a result, only a few Brazilian soybean producers have joined the RTRS programme, and their share of total certified national production remains low.[133] Therefore, China's more active participation is extremely important for the transnational governance of soybean land use in South America.

In fact, as a country with over 4,000 years of soybean cultivation history, China has accumulated a wealth of sustainable soybean production experience. This precious agricultural heritage continues to remain highly relevant for the sustainable development of agriculture today. For example, the no-till technology of soybeans, which was already being used by the Chinese more than 1,000 years ago,[134] is nowadays being widely used in the soybean production field in South America. Therefore, China's increased involvement in transnational governance may help to promote its agricultural heritage worldwide, contributing not only to Chinese food security but also to global food security.

Fortunately, attitudes in China and Brazil towards sustainable soybeans have changed in recent years. At the G20 Conference on Sustainable Vegetable Oils held in November 2022 in Bali (Indonesia), the Chinese government attached great importance to the sustainable development of the vegetable oils industry, including

[131] Oliveira & Schneider, n. 37 above, p. 177.
[132] Bowman et al., n. 126 above, p. 264.
[133] Schleifer, n. 128 above, p. 689.
[134] Y.X. Song, *Heavenly Creations* (Commercial Press, 1933), p. 8.

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the sustainable production of soybeans.[135] In a joint statement signed by Brazilian president Lula during his visit to China in 2023, China and Brazil highlighted their common concerns regarding deforestation and climate change.[136] Both countries agreed to establish a subcommittee on environment and climate change under a high-level coordination committee between China and Brazil. Although the statement did not mention sustainable soybean land use, these efforts demonstrate the goodwill of both countries to cooperate and promote sustainable development, which provides a solid political basis for China to become more involved in the future governance of soybean land use in South America.

Improvement of public-private partnerships

Public-private partnership is a governance method that focuses on cooperation between governments, NGOs, and the private sector. This method of governance has received considerable impetus since the 2002 World Summit on Sustainable Development held in Johannesburg (South Africa),[137] and has already been used in the transnational governance of land use for other agricultural products, such as the sustainable production of and trade in palm oil.[138] Through public-private partnerships, state and non-state actors in a polycentric governance system can connect multiple elements (such as the state, the market, and society) and play an important role in bridging the divide between environmental and agricultural interests.[139] However, at present, there is still no well-functioning public-private partnership for the transnational governance of soybean land use in South America.

In the existing transnational governance system, the voluntary standards of non-state actors play an important role, but the role of the state has not been fully utilized. European countries have made efforts to promote zero deforestation soybeans in South America, but for other sustainability issues, such as the abuse of agricultural chemicals and monoculture, the EU and its Member States have not introduced specific governance measures. Meanwhile, China, as a world trading power, has not enacted transnational supply chain laws to prevent the import of unsustainable goods. There is also a lack of effective cooperation between state and non-state actors. State actors have failed to reasonably regulate and provide necessary support for the development and implementation of these standards. In practice, the voluntary

[135] Ministry of Agriculture and Rural Affairs, 'Vice Minister Ma Youxiang Attends G20 Sustainable Vegetable Oils Conference', 4 Nov. 2022, available at: http://english.moa.gov.cn/news_522/202211/t20221104_301004.html.

[136] 'Brazil-China Joint Statement on Combating Climate Change', *China Daily*, 16 Apr. 2023, available at: https://www.chinadaily.com.cn/a/202304/16/WS643b6b37a310b6054facdd92.html.

[137] F. Biermann et al., 'Earth System Governance: A Research Framework' (2010) 10(4) *International Environmental Agreements: Politics, Law and Economics*, pp. 277–98, at 283.

[138] A.M. Schouten & O. Hospes, 'Public and Private Governance in Interaction: Changing Interpretations of Sovereignty in the Field of Sustainable Palm Oil' (2018) 10(12) *Sustainability*, article 4811.

[139] C. Brannstrom et al., 'Compliance and Market Exclusion in Brazilian Agriculture: Analysis and Implications for "Soft" Governance' (2012) 29(2) *Land Use Policy*, pp. 357–66.

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governance of non-state actors relies mainly on their own actions, which are easily influenced by external factors as they are just voluntary soft laws.

Therefore, to achieve polycentric governance for the telecoupled soybean land-use system in South America, effective cooperation between state and non-state actors needs to be promoted. To this end, state actors may introduce the meta-standards approach and strengthen the supervision of non-state actors' voluntary standards to prevent their potential drawbacks, similar to the methods used in the transnational governance of sustainable biofuels in the EU. As the biggest market for South American soybeans, China has great potential in the development of public-private partnerships of polycentric governance. From the perspective of state actors, the Chinese government may enact a specialized supply chain law to strengthen the due diligence obligations of multinational corporations in the sustainable soybean supply chain to prevent the import of soybeans produced in unsustainable ways into the Chinese market. From the perspective of non-state actors, Chinese multinational corporations may make full use of voluntary standards, either establishing their own or adhering to existing standards established by other non-state actors.

Establishment of a knowledge-sharing platform through international cooperation

Polycentric governance is regarded as an additional solution for the governance of a complex system when a single policy prescription is failure to achieve the goal, as it can more effectively and equitably contribute to the achievement of sustainable outcomes at multiple levels.[140] However, the implementation of polycentric governance still faces a series of challenges. Coordination among the anticipated centres with different objectives, as well as information asymmetry between actors,[141] have resulted in inefficiency and high governance costs. The relative immaturity of the sustainability agenda in the global commodity market also means that credible and relevant information on supply chain sustainability is often in short supply, presenting a major barrier to effective governance.[142]

These deficiencies also exist in the transnational governance of soybean land use in South America, obstructing the establishment and implementation of a polycentric governance system. For example, divergences on the purpose of soybean production and trade make it difficult for China to accept the RTRS from Europe; this is why the RTRS has made several attempts to promote its standard among Chinese buyers, but with limited success.[143] Owing to the absence of details of South America's soybean cultivation in the consumer markets, it is difficult for the soybean-importing countries to detect whether imported soybeans are produced in a sustainable or an unsustainable way.

[140] E. Ostrom, 'Beyond Markets and States: Polycentric Governance of Complex Economic Systems' (2014) 76(5) *Revista Mexicana de Sociología*, pp. 15–70.

[141] M. Bostrom et al., 'Sustainable and Responsible Supply Chain Governance: Challenges and Opportunities' (2015) 107 *Journal of Cleaner Production*, pp. 1–7.

[142] T.A. Gardner et al., 'Transparency and Sustainability in Global Commodity Supply Chains' (2019) 121 *World Development*, pp. 163–77.

[143] Schleifer, n. 128 above, p. 694.

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Knowledge sharing means the exchange of task-related information to help others and to collaborate with others in carrying out daily tasks, solve problems, and develop new ideas.[144] Knowledge sharing between various components of a complex system is a prerequisite for successful governance.[145] A knowledge-sharing platform for polycentric governance of the telecoupled soybean land-use system in South America can help to overcome the challenges mentioned above by reducing conflicts, increasing transparency in the supply chain, and promoting mutual trust between the various centres. Since China and Europe are the two main markets for South American soybeans, and Brazil is the main soybean exporter in the world, cooperation between China, Europe, and Brazil is especially important for the establishment of a knowledge-sharing platform. Despite significant differences among them, the common concerns regarding global sustainable development and the 2030 Agenda for Sustainable Development[146] will provide a foundation and guideline for such cooperation.

5. Conclusion

Telecoupling is an emerging concept that seeks to elaborate on the interaction factors between distant places. It thus constitutes a novel approach to address the challenges that traditional international governance is currently facing in a globalized era. A polycentric governance approach is considered more adaptive and inclusive at an appropriate scale for telecoupled land-use systems. This study applied the polycentric approach to transnational governance of the telecoupled soybean land-use system in South America to overcome spatial disconnections and responsibility deficits intrinsic in the existing transnational governance system and to explore new ways to promote sustainable governance of telecoupled soybean land use in South America. Moreover, it provides suggestions for the improvement of the existing transnational governance system from a macro perspective through the polycentric approach.

However, further research is still needed to address micro-level issues related to the polycentric governance of telecoupled soybean land use in South America, such as traceability of South American soybeans, the formation of meta-standards, and the establishment of a dispute settlement mechanism. As the soybean land-use system in South America is regarded as a typical telecoupled system, this study's findings have implications for the transnational governance of other telecoupled land-use systems, such as the trade and production of meat, coffee, and cotton, which are also affected by factors in distant international consumer markets and face the problem of sustainable land use.

[144] A. Yeboah, 'Knowledge Sharing in Organization: A Systematic Review' (2023) 10(1) *Cogent Business & Management*, article 2195027.

[145] N. Obeid & A. Moubaiddin, 'Towards a Formal Model of Knowledge Sharing in Complex Systems', in E. Szczerbicki & N.T. Nguyen (eds), *Smart Information and Knowledge Management* (Springer, 2009), pp. 53–82.

[146] N. 69 above.

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