Forestry's Enduring Debt to German Science

William F. Hyde[1]

Abstract

The development of forest science over the last three centuries is largely a story of debt to its German beginnings—which I will tracer briefly. The debt continues to this day and it continues with the issues that are globally most important within forestry. I'll suggest two modern examples of German leadership, satellite imagery and well-considered German caution regarding the concept of community forestry, then continue with a request for continuing German leadership on two newer topics, the role of forests in global climate change and the dominant impact of exogenous macroeconomic and policy variation over even the "best" of forest policy.

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Introduction

I'm honored for the invitation and pleased to attend today, but it's a special honor to join those whose history is the very source of forest science in general and my discipline within forestry in particular. Mine is an outsider's perspective of the German contribution to the science of the rest of us, world-wide, but I think my perspective is shared by most of our international colleagues. It is a compliment to both your history and your world view.

Yours is a history that introduced us to a science of forestry, and the components of that early history remain a foundation of modern forest science to this day. I'll begin with a review of the origin and development of our science as I understand it, a three-century chronology of the fundamental German contributions which I'll only summarize now but place in an appendix with more detail. Then I'll add my personal reflections on your modern contributions. The latter are my perspective on both what those modern contributions of late seem to be and what they could be going forward. It's a perspective that is only possible because German forest science continues, today, to reach globally.

My presentation will be brief, and you'll be familiar with many of the details. I'll look forward to your comments and, perhaps, your corrections in discussion afterward.

Forestry Education

[1] Retired independent researcher, wfhyde1@gmail.dom. Presented at Forstwissenschaftliche Tagung (biennial meeting of German forest scientists), Dresden, September 11-13, 2023. Virginia Morales Olmos, William Bentley, Runsheng Yin, Shashi Kant, Peter Deegan and Norbert Weber all provided useful comment and insight on earlier drafts.

Let's begin with the German language contribution to forestry education—as education often coincides with the origin of scientific inquiry—then proceed to that which I know best, the contribution to forest economics, management and policy.

To my knowledge, Wilhelm Gottfried von Moser's 1757 *Principles of Forest Economics* is the origin of a literature in forestry. Forestry education began a little later, in 1795, at the Royal Saxon Forest Academy at Zillbach. Others followed, at the University of Berlin, the University of Giessen, and the Academy in Mariabrunn. The first opportunities in forest education were shorter field programs or individual classes. Higher education in forestry and academic forestry degrees came later.

The same was true for the initial forestry programs elsewhere, away from forestry's German homeland, and somewhat after its German beginning, Most of those others relied on German teachers or German language material as they first set out. To my knowledge, only two were less reliant on German material: the French who began their own program at Nancy in 1822 and the Japanese who began their first university-level forestry classes at Kyoto Imperial University and Tokyo University in the 1880s and 1890s.

Looking still elsewhere and on into the 20th century—the US, Canada, Great Britain and India, even China, and then later still, Latin America—takes us back to initial German contributions. Bernhard Fernow, a German graduate of the Prussian Forest Academy at Munden, became an early director of the US government's Division of Forestry in 1886. He subsequently introduced the first 4-year college curriculum in forestry at Cornell in 1898 and the first Canadian curriculum at the University of Toronto in 1907. Dietrich Brandis, a botanist from Bonn, was the earliest advisor to Gifford Pinchot, the first American trained as a forester. He recommended Pinchot's own education path and, later, the model for Pinchot's organization of the US Forest Service.

Brandis had already made substantial contribution elsewhere. He was the Inspector General of the Imperial Forest Service of India, beginning in 1864 and serving until 1883, then subsequently directed the Royal Indian Engineering College in England. In 1906 he became the first director of India's new forestry school at DehraDun. Today, Brandis is recognized as the father of both tropical forestry and scientific forestry in general.

Also in Asia, China began its first higher education program in forestry in 1903. The early Chinese instructors were returning students who were trained in Europe, North America or Japan, often in the German tradition of those early European and North American schools.

Forest Science

Most of you know this chronology of early forestry education. Let's turn to the German contribution to modern forest science—with the apology that I'm not a good one to comment on forest science in general. I do recall from my own introduction to forestry that silviculture, that most fundamental of forest sciences, began in Germany. Beyond that, I'll restrict myself to that portion of our science with which I'm most familiar: economics, management, and policy.

Modern forest economics and management began with Johann Heinrich von Thunen's 1826 introduction to the subject matter of economic geography, an introduction which included a forest component that was extended specifically for forestry in the third part of his initial work published much later in 1863. What von Thunen outlined for us is still relevant—and often too easily overlooked. But more on that later.

My own formal introduction to forest economics and management was Martin Faustmann's 1849 determination of the optimal rotation for a single forest stand. Von Thunen, however, is more important, to my mind, because he includes multiple rings of sustainably managed forest of different ages and, therefore, different management and then, somewhere more distant than his last sustainable ring, the possibility of unmanaged forest that, in many places, extends most expansively. This distant unmanaged forest remains the source of more than 50% of all consumable products removed from the global forest even today.

In any event, we can conclude once more that German science was the source for an important component of forest science; for me the major source within my own experience in forest economics. Furthermore, the questions of modern forest economics and management today continue to rely heavily on those original German sources.

Forest Science Over the Last 50 Years

I'd like to move on—to forest science over the last 50 years, the period of my personal knowledge. I see two items for compliment and two newer items of which to ask for German leadership. The first two are the German role in satellite imagery and the very different but related topics of tenure and collective action in forestry. The second two are global warming and incorporating exogenous risk into forest planning. I'll describe my experience with each of the four in turn.

I was introduced to remote measurements of forest inventories in graduate school in the early 1970s. Satellite imagery for forestry seems to have begun sometime after that. My introduction to its actual application came during work in Nepal in the early 1980s where GTZ had contracted for an inventory of Nepal's forests. Were there other early applications of satellite imagery in forestry? Probably. But the German/Nepal experience was certainly one of the first and this was the first known to me. I confess that, to me at the time, the GTZ contract seemed little more than a means to support a German consulting firm. Satellite imagery was ridiculously expensive and Nepal's foresters would never have the skills to use it—or so I thought. I was wrong—as all of you know. Satellite imagery is widely used today, by national forestry agencies, by mature researchers, and even in very many graduate student theses. Two of my own M.S. students have served as Chief of the Nepal Department of Forests and Soil Conservation and both assure me that Nepal uses satellite imagery in its inventories today. Clearly, to me, German forest scientists were among the very first to apply the satellite imagery that has become a global foundation for forest inventories today.

The second is the very different observation that German forest policy advisers and researchers, while actively involved in international forestry do not, to me, seem as involved as

many others in simple and often erroneous recommendations for improved land tenure as the means to reduce forest degradation and deforestation. As von Thunen showed us, some forest still remains beyond the distant margin of consumptive economic activity. In parts of the US and Canada, Siberia, Brazil and Peru, Indonesia and Africa, these distant forests contain the largest shares of the total forest inventory. On most of these financially extra-marginal lands, the cost of imposing and maintaining secure tenure is greater than the resource value at risk and successfully imposing tenure would be both wasteful and largely ineffective.

The somewhat related issue of community forestry generally recommends transferring state agency forest responsibility to local communities with the expectation that those communities will manage more sustainably. The concept is promoted by numerous development agencies, NGOs and many social scientists working in forestry. It has not been the panacea that many anticipate. Community forestry (or any collective action) succeeds when the collective value held by all members of a community is greater than either the individual private valuation or the costs of protecting the resource. It is the justifiable economic argument for central town commons and state and national parks, for special provisions for biodiversity and for some watershed management.

Community forestry has not been very successful when individuals or groups of individuals have competing interests for the resource. It is not a successful replacement for individual control where private values are sufficient to insure successful management—as the Chinese experience (and many others) with collective management shows us. The Chinese tried collective forest management and their forests declined precipitously from 1949 until 1978. When some collective rights were restored to individual households in some parts of the country in 1978, those household forest properties began recovering immediately, and sometimes spectacularly. Finally, community forestry is not a solution for those forests that, as von Thunen showed us, are beyond the sufficient geographic reach of either private or social value. The theoretical evidence is convincing and extensive empirical evidence confirms it.[2]

Much of the discussion of these two tenure-related issues is troubling to me because it does not help promote sustainability of the forest or its resource services and it is not instructive for the management of forests to promote biodiversity or mitigate climate change. The related policy prescriptions can even be wasteful of human and financial resources when those resources are dispersed for use on distant or otherwise less accessible extramarginal lands. However, if I am correct that these issues have not been promoted by German forest scientists as much as by those elsewhere, then a compliment to your caution is appropriate. There are, nevertheless, roles for improved tenure and for community forestry or other collective action in the locations where

[2] Yin (2003) and several who have followed explain this China experience**.** Kant (1996) provides an excellent example from Orissa and West Bengal in India. Stiglitz and Rosengard (2000), a standard textbook for public finance**,** outlines the fundamental principles. Anderson and Agrawal (2011) survey the extensive empirical literature in developing country situations. Hyde (2016) provides a broader review of developed as well as developing country experience.

those would make a difference.[3] I would only ask that German foresters take a larger role in reminding the rest of the world of the appropriate applications of von Thunen's principles.

Looking Ahead

Finally, I promised two additional and newer issues for which German foresters could take a leading role—and I hope you will. The first, global warming, is well-known to all of us. The second is a variety of uncertainty that forestry overlooks almost entirely, but a variety that can impose an almost total restriction on forest policy and management in some parts of the developing world.

I'm not an expert on global warming, but I have observed its astounding impact on some forests and I am only too aware of the reluctance of some, especially in my own country, to address the problem. Bark beetle damage is the most graphic example of my personal observation. As I understand it, warmer winter weather allows greater larvae survival with the resulting increased likelihood of epidemic damage the following year. In North America, bark beetle damage visible to any human eye, now extends 5,500 km from Canada's Yukon border with Alaska, down the Rocky Mountains all the way to Mexico City. This stuns me and I cannot understand how anyone can ignore it—especially given its relationship to our immense problems with wildfire. But last December I saw worse, much more complete and more rapid destruction in the Harz Mountains in Lower Saxony. You probably know this. Bark beetles destroyed, completely destroyed, an entire forest within the six years since I last visited. A new forest may eventually recover but, meanwhile, the watershed suffers and the local human community suffers as well. Buildings are boarded and closed and the outdoor activities and tourism of six years ago no longer exist. The transition can only include extreme expense and the exceeding social hardship is undeniable.

Of course, insect damage and the transformation of the structure and productivity of forest ecosystems is only one part of the forest's role in climate change. Two further components are also critical: forests as systems of carbon sequestration and the transformation of the patterns of consumption of forest products. Until others understand all three component issues better, I can only hope that German scientists, foresters of both natural and social science background, do more to expose the horrible examples you recognize at home and continue to show the world the global similarities to your examples and the global importance of all three components of forestry's crucial role in this universal problem.

The final item is a newer consideration for foresters, the impact on forestry imposed by uncertainty in the broader environment exogenous to forestry, uncertainty caused by civil unrest or by macroeconomic or policy-induced fluctuations over which foresters have no control. Foresters know about the risks of natural hazards like insect epidemics and wildfire and the uncertainty they impose on forest production and we incorporate those in many of our analyses.

[3] I made this point in more extensive discussion (Hyde 2012) but the best concise statement known to me is in an article in The Economist (How to preserve nature …, 2019) with citations to Joppa and Pfaff (2009) and Pfaff et al. (2014).

Uncertainty imposed on the forest sector by the broader macroeconomic environment is different. It is a newer concept for us because we've been trained and we conduct our research with examples from Western Europe, North America and East Asia where economic and political stability is largely the norm and broad-scale instability and uncertainty are uncommon.

But not all economies worldwide have been or are so stable. Great fluctuation in the broader environment, whether the obvious case of civil unrest (*e.g*., Liberia and Cambodia in the 1990s) or those cases of macroeconomic mismanagement leading to wide swings in exchange and interest rates (*e.g*., East Asia during the 1998 financial crisis or the seemingly perpetual case of Argentina) creates uncertainty throughout the forest sector. It causes loggers to harvest more rapidly and farther into the distant margin while they have the means and while the opportunity still exists. It also deters any long-term investment, whether for improved management, modernizing equipment or establishing new long-term capital investments like plantations or facilities like mills. Investors simply cannot depend on an expected future return in the presence of this exogenously imposed uncertainty. It fundamentally overwhelms the best-designed programs for forest policy and management and makes otherwise good forest policy prescriptions meaningless (Hyde and Morales Olmos 2023).

The contrast of Argentina with a history of wide shifts in its fundamental macroeconomic environment with that of more stable Brazil, Chile and Uruguay is only one example. The four countries share similar forest characteristics and similar levels of economic development but Argentine roundwood production has grown as little as $1/10^{th}$ the rate of that for neighboring Uruguay. Argentine investments in plantations have grown at 1/3-1/5 and production in pulp and paper has grown at 2/5 to $1/20^{th}$ the rates of Brazil, Chile, and Uruguay—all because of Argentina's "sclerotic" broader macroeconomic environment.[4]

Foresters are unlikely to be able to affect the sources of uncertainty that is exogenous to any of their activity. Nevertheless, foresters must recognize it as they prepare recommendations for the many countries with less stable macroeconomic and policy environments. What might otherwise be the "very best" forest policy simply cannot succeed in countries affected by this form of uncertainty. The extensive resulting misdirection and waste in the otherwise very different economies of Cambodia and Malawi, for example, is unmistakable. I'd encourage German forest scientists, whose math skills and alertness to risk and uncertainty have always been strong, to pursue this point and to share their results. I am confident that a better understanding of this form of uncertainty would caution the advisors of forest management and policy for many developing countries, and even some more developed countries like Argentina. It would also redirect and even save on the human and financial resources that are so scarce for the very many poor countries that experience macroeconomic instability.

Conclusion

[4] The term is from the Economist (Political stability: why Uruguay? Economist, February 26, 2022, pp. 33-34).

I promised to be brief. I hope it's clear that I admire the preparation your earlier colleagues have given me. More importantly, the experience of colleagues in other parts of the world is convincing that this debt to German forest science is shared globally. You have prepared us well for our chosen field of education and scientific inquiry. We admire the breadth of German science across the sub-disciplines within forestry and we respect its sustained impact. The entire forestry profession looks forward to the continuing contribution of great German forest science, and I look forward to your comments in the discussion that follows.

Appendix: A (Slightly) More Detailed Chronology

To my knowledge, Wilhelm Gottfried von Moser's 1757 *Principles of Forest Economics* is the very beginning of a literature of forestry. Moser built on the cameralists' and Hans Carl von Carlowitz' earlier concept of sustainability (*Sylvicultura oeconomica*, 1713) and, by 1804, German forestry had a recognizable concept of sustainable management (Wiersum 1995, Ulrich 2007, Deegan and Seegers 2011). Forestry education began about the same time—with the first permanent program beginning only a little later at the Royal Saxon Forest Academy, established in 1795 at Zillbach and moved right here to Tharandt in 1811. The Forestry Academy of the University of Berlin (1821) and the School of Forestry at the University of Giessen (1825) followed, as did the Academy in Mariabrunn in 1833 which eventually, in 1913, became a school of higher education. The first opportunities in forest education seem to have been field training programs, shorter programs, or just one or two classes within a broader education program, often an agricultural program. Forestry classes associated with institutions of higher education and, eventually, university-style academic forestry degrees, came later.

The same was true for the initial forestry programs elsewhere, away from forestry's German homeland, and we know that some of those others depended on German teachers or German language material as they first set out. Can we presume that programs in Slovakia at the Mining Academy in Banská Štiavnicin in 1807, in Poland at the Warsaw School of Forestry in 1816, and in Sweden at the Royal Forestry Institute beginning in 1828 benefitted from training, teaching materials, and even teaching associations with those prior German classes and schools? The first director of Spain's Special School of Forest Engineers established in 1835 was German. And, of course, the first Swiss classes in 1855 and, in 1878, the first three Austrian schools with short courses in forestry are integral parts of forestry's German language heritage.

Beyond Germany

Others did, independently, begin to recognize the importance of forestry as its own subject matter, and we cannot disregard them. A good colleague of French descent would not allow me to overlook the early (1822) center of forestry education at Nancy, and the French too have sent their trained foresters to other parts of the world. Nancy was a 2-year program—including substantial non-forestry components (*e.g.*, 150 hours of horsemanship). Higher education in forestry in France, as elsewhere, did not begin until much later in 1924, somewhat

after the first higher education program in Germany in 1913. In Asia, Japan had a system of forest management and a literature in silviculture by the 18th century under the Tokugawa Shogunate. The first university-level forestry classes were taught at Kyoto Imperial University and Tokyo University in the 1880s and 1890s. A small number of Japanese students studied elsewhere, including here at Tharandt, but we know that Japan did not have an impact like Germany's on students from outside of Japan until somewhat later.

Looking still elsewhere around the world—the US, Canada, Great Britain and India, and then China and Latin America—takes us back to initial German contributions. Bernhard Fernow, a native German graduate of the Prussian Forest Academy at Munden, became an early director of the US government's Division of Forestry in 1888. Fernow did more than this. He introduced and taught in the first 4-year college curriculum in forestry at Cornell in 1898. (The Cornell program was later transferred to Syracuse.) A decade later, he introduced the first Canadian curriculum at the University of Toronto in 1907.

Gifford Pinchot, the first native American with technical training in forestry, attended Nancy, but only after the advice of Dietrich Brandis whose contribution we'll look at more closely in a moment. Pinchot became the first forest manager in the US, directing forestry at the Biltmore estate in North Carolina, where he began the first forest technician program in the US. When he moved on, eventually becoming the first Chief of the US Forest Service, Pinchot sought Brandis' advice again, organizing the US Forest Service after Brandis' model for India—which followed a cameralist regional organization. Subsequently, with Brandis' advice, he recommended Carl Schenck, a graduate of Giessen, as Biltmore's new director in 1885.

While Brandis's contribution as mentor to early North American foresters, was invaluable, his global contribution was surely even greater. When the British first searched for a forester, they selected Brandis, a trained botanist, who introduced what we now know as the "taungya" system of sustainable forestry in Burma. This was the beginning of what in the late 20th century became widespread interest in what we now call "community forestry". Brandis was, for 20 years (1864-1883), the Inspector General of the Imperial Forest Service of India. He subsequently directed the Royal Indian Engineering College in England (1888-1896) and, in 1906, he became the Director of India's new forestry school at DehraDun. Today, many recognize Brandis as the father of both tropical forestry and scientific forestry in general.[5]

I previously mentioned a good friend and colleague of French descent. It's now time to refer to the knowledge of several good Chinese colleagues. Once more, German forestry plays a role, both directly and indirectly. China's first program of higher education in forestry began in 1903 with 2-year vocational training and 4-year professional training, the latter at Peking University, still China's leading institution of higher education. That program became the independent Beijing Forestry University in 1952—with over 12,000 undergraduate students today, undoubtedly the largest school of higher education in forestry in the world. (Forest

[5] These first six paragraphs rely on Clepper (1971) and Filewod (2022) as well as personal recollections. Clepper is a remarkable collection of information about the history of US forestry. Filewod is a recent, an equally remarkable, PhD dissertation measuring the sources of global forest development. His chapter 4 and appendix J provide a chronology of international forestry education as well as many fundamental citations.

science study groups were eventually formed at other Chinese universities and there are now three major universities in China devoted entirely to training in forestry.) The early faculty at Peking were returning Chinese students who were trained in Europe, North America or Japan, most often in the German tradition of those early European and North American schools. Four prominent Chinese scientists of only slightly more recent experience; Wang Zhen, the founder of forest soil science in China; Zhou Zheng, the founder of forest management in China; Liang Xi, the first Minister of Forestry for modern China (after 1949); and Chen Rong, the first president of modern China's Academy of Forestry; all studied right here in Tharandt in the 1920s.[6]

Finally, forestry education in Latin America began still later, first with Mexico's program at Chapingo in 1909. Others followed in the 1940s (Chile, Costa Rica and Venezuela) and later, once more with faculty trained in the German tradition or its North American derivative.

Forest Economics, Management and Policy

Modern forest economics and management began with Johan Heinrich von Thunen's formal introduction to the subject matter of economic geography—not just forestry—in 1826. Well after I was introduced to von Thunen's concept of expanding rings of mostly different agricultural activities around a central value center, I read the full English translation and learned that von Thunen had included forestry as his second sustainable ring. Still later, your colleague and mine, Peter Deegan, showed me that von Thunen had extended his forestry analysis in more detail in the third part of his initial work, but work that was not published until much later in 1863. Peter also introduced me to the cameralists who preceded von Thunen and their concept and regional organization for forestry, and then led me on a most appreciated—and educational—visit to the von Thunen property at Tellow near Rostock.

It is my own perspective that what von Thunen outlined for us is still relevant—and often too easily overlooked. I think that a better understanding of expanding rings of more distant economic activity, but rings of increasing cost, around an economic center would improve our understanding of just what is possible for forest management and policy in many developing regions of the world and even in some forested parts of developed countries like the US and Canada. In fact, I could state this more strongly. If forest policymakers understood von Thunen they would modify and improve many of their recommendations for tropical forest management and, indeed, for the organization of forests for protecting biodiversity and mitigating climate change.

My formal introduction to forest economics and management began with Martin Faustmann's 1849 determination of the optimal sustainable forest rotation. I now recognize that, while sustainable rotations are important, the majority of global forest removals, even today and for whatever purpose, come from the unsustainable forest frontier. Plantations, those sustainable forests that are most likely to follow a Faustmann-like rotation, comprise only 7.4% of the world's forests (294 million ha of a global total forest of almost 4 billion ha, FAO 2020). Indeed, the majority of forests, plantation or otherwise, even in a dynamic industrial forest region like the US South, are not managed for any sort of optimal Faustmann-like rotation.

[6] I owe the information about the four Chinese scholars at Tharandt to Norbert Weber.

Von Thunen is more important, to my mind, because he includes multiple rings of sustainably managed forest of different ages and, therefore, different management and then, somewhere more distant or less accessible than his last sustainable ring, a region of unmanaged forestland, some portion of which continues to produce important measures of both extractive forest product and non-consumptive forest resource services. Property rights of any sort whatsoever are difficult and expensive to enforce in this distant unmanaged forest, and one crucial lesson from von Thunen should be that it's best to focus policy, for whatever objective, on those forested "rings" within the managed area plus that additional forest at the shared boundary of managed and unmanaged, economically sub-marginal and extensive, forest. It is best to avoid wasting resources on those inaccessible and distant resources that are not threatened by consumptive human use.

Nevertheless, I do not intend to disregard Faustmann's contribution. For very many of my fellow economists, Faustmann is the beginning of our discipline and the many extensions of Faustmann remain a central feature of the modern literature of forest economics: extensions, for example, to meet the specifics of uneven-aged management, intermediate stand treatments, some taxes and regulations and varying prices, then developed further to include non-market forest resource services and different ownership objectives, then fully modified even further yet as a true profit function (Yin and Newman 1997) more in conformity with the lessons of von Thunen. Furthermore, I expect that the insights of Faustmann and of those more recent extensions will gradually become more important as more of the world's forest follows the observed long-run global trend toward further management.

In any event, and no matter one's own interpretation or preferences, it is clear that the most modern of forest economics, management, and policy anywhere on this earth remains not only indebted to the German science that precedes us but also continues in its development to this day with that basic German science as its foundation.

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