Interdisciplinarity in 19th and Early 20th Century: Reflections on Ecosystem Services of Forest

Axel Bader
Georg-August-Universität Göttingen, Büsgenweg Göttingen, Germany
&
Christoph Riegert
Bavarian Forest State Forest Service,Regensburg, Germany

Abstract
Reflecting on forest functions links forestry and the society since the 19th century, thus demanding early forms of interdisciplinarity. In this essay we trace back the history of the research on forest functions to its very beginning. We present the most influential conceptualizations on this topic in the last 180 years. Including forestry science, political science, history, and economics, protagonists met this challenge by showing an interdisciplinary interest in their other works, too. Since the 19th century, many different terms have been used to describe the relationship between forestry and society, including 'forest uses', 'forest effects', 'forest tasks', and 'meanings'. This did not only lead to a confusing use of terms but the protagonists did not build on, and connect with each other either. For that reason, a research tradition could not be established. The overview of the development of the different terms is followed by a suggestion to amalgamate the concepts: Today, a society's demands to a forest should be named 'tasks' of a forest. If the forest is producing 'natural effects' that make it possible to satisfy these 'tasks', we should talk about 'services' that are delivered by the forest.

[**Keywords:** Interdisciplinarity, 19th century science, forestry, humanities, social sciences, forest functions, ecosystem services, forest effects, forest meanings, forest tasks]

Terms to clarify, terms to nebulize

What are ecosystem services? What are landscape functions? And what are the cultural and scientific columns for such a concept of evaluating a landscape? In this article, we try to find answers to these questions by examining the concept of forest functions, a concept that has been in use in German forest science since the early 19th century. Forest functions describe the relationship between forests and the society: What do humans expect of forests and what are forests (and forestry) able to provide? On the threshold between humanities, social sciences and forest science, the question of forest functions is one of the first scientific inter- and transdisciplinary discussions.[i] It has even established such a tradition. In contrast to established theory of landscape functions as presented by Bastian and Schreiber[ii], we focus on forests as a certain part of landscape.

The meaning of the concept of forest functions has changed constantly since it has first been mentioned in the 19th century. Looking at early forest science literature, we find many different names for one and the same thing. Our second task is, therefore, to offer a distinct concept of differentiation between the terms *forest uses*, *forest effects* and *forest tasks*. These terms are not only meshed up but also used synonymously, thus leveling out the slight differences between them and undermining any scientific discussion.

We can show, that from the first scientific works dating from the early 19th century on, the names of the functions of forests as landscape types have changed but that the inherent meaning has stayed the same throughout all time.

We do not intend to write a history of misunderstandings or synonyms. Therefore, a distinct definition of what we call a forest function is necessary. According to Victor Dieterich (1953)[iii] a forest function is a societal demand posed to forests like wind protection or water retention. Among the functions are the capital, the income, the work, the resource, and the area function. Dieterich intended to describe the relationship between forests and people (p.24). His aim was to show the role of forests to people's welfare. His assumptions have been very influential to modern forest scientists not because he was the first one to name it, but due to his concise elaboration and logical composition of ideas. With his *Funktionenlehre* of 1953 he formed a doctrine. The widespread references among forestry literature lead to an adaptation of his quota to our concept. Dieterich (1879 – 1971) was Professor for Forest Policy and Economics in Munich.

Traces of Dieterich's function-doctrine in the early 19th century

Dieterich's doctrine of 1953 relied on earlier works. Before he had begun the theoretical reflections on forest functions, other forest scientists had published similar ideas, but no coherent concepts. Already in 1807, Konrad Anton Zwierlein (1755 – 1825), a Bavarian spa doctor, published "On the great influence of forests on culture and happiness of states"[iv] in which he postulated forests' health promoting abilities. This was in line with the German Zeitgeist that had recently rediscovered forests as 'national' landscapes.[v] At this time, an additional medical surplus was very welcome which makes it hard for nowadays readers to separate Zwierlein's medical from the inherent national goals. Without much ado he scaled his individual experiences of treating patients in a spa in a Bavarian forest up to the national level. What the fresh forest air does to sick patients it also does to states, and in 1807, during the Napoleonic wars, the German states were sick indeed. Even if his conclusions seem to be *de trop* today, he was the first to postulate the positive effects of forests to humans and even to the society.

In 1825 Alexandre Moreau de Jonnès (1778 – 1870) wrote his influential "*Memoires sur le déboisement des forêts*"[vi], which were published by the royal academy in Brussels, and which therefore had a wide and international audience.[vii] All these treatises ventilated ideas of positive effects of forests on humans, cultures and even states besides wood production. These effects were known for a long time, even Plato had mentioned the notion that deforestations change the physical setting of a countryside and might even result in severe problems for its inhabitants (Plato: Critias). In the early modern time, several Spanish and Portuguese captains had similar notions when they compared the inhabited but clear-cut coastlines of the Mediterranean to the newly found shores full of mangroves and forests of the New Indies. These notions lacked the practical usefulness for a long time. They were rumors among early modern explorers, but did not enter any scientific discussion.

When the French Revolution with its large deforestations resulted in severe harms to welfare, many forest administrations reported damages. This was the starting point for a scientific approach to the general welfare functions of forests. It became

obvious, that the public interest in forest protection now included a forest's mechanical protective effects. Now, a forest's influence on the temperature and the humidity of the air and the ground was examined. Each result contributed to the notion that forests even out climatic amplitudes, that they have a positive effect on water circulation and protect against strong winds and avalanches.

1900: Forest functions between welfare and economic benefits

Around 1900, forestry science had accomplished major steps in the research on these welfare functions. Max Endres, professor of forest policy in Munich summarized the respective researches in 1905 and called them welfare effects ("Wohlfahrtswirkung").[viii] Inadvertently, his outline shows much more than a simple summary of 19th century research progress. It was one of the first genuine interdisciplinary works. Himself being a forest scientist and a professor for forest policy, he collected results from different disciplines to produce advances in the understanding of forest's natural effects and tried to make these effects useful for the welfare of mankind. Furthermore, he suggested implementing other discipline's research methods into forest science in case they seemed promising. Nevertheless, problems aroused.

These welfare functions were there, as different disciplines proofed, but no one wanted to pay for them. They were not remunerable in the 19th and early 20th century. More and more demanded a protection of these forest functions, but for forest owners and foresters, a financial refunding was hard to get. Furthermore, the protection restricted the wood production which was the only economic resource that forest owners could rely on in the end of the 19th century. A discussion arose, that even disavowed a forest's welfare functions in complete. Julius Lehr (1845 – 1894)[ix], a political economist and forest scientist, argued that the ideas of forest welfare functions arose out of a "hot romantic feeling"[x] (p. 110) but could not withstand a "cool multi-perspective consideration" (ibid.). Having these catchwords in mind, it seems like irony that his argumentation lacked the scientific grounding, but had some good points. His arguments were cited frequently but normally rejected as being too extremist. Nevertheless, Lehr applied a strictly economic view on the problem. A natural effect that does not pay off cannot be called 'function'! To him, it seemed to be easier to deny all forest effects that do not play an economic role and focus on effects that contribute vitally to a forest owner's income.

Forest functions to the national socialist society

In 1943 Konrad Rubner (1886 – 1974), a professor of forestry in Tharandt/Dresden, had published a textbook on forestry science. Rubner discovered "tasks of forestry"[xi] (p.7) and referred to Heinrich Eberts earlier conceptual work.[xii] Eberts was a German professor of forest policy and economics. In the 1940s, he wrote a bill for the national socialist federal forest law and was later an assistant secretary of state. Konrad Rubner's perspective was far-reaching, when he included social, national economic (p. 8), and national cultural tasks, and in line with the Zeitgeist, when he reflected on people's cultural and military economic and military technical tasks (p. 9) which could nowadays be read as national socialist aftermaths. The two latter tasks would form a military political forest function, which would be able to elevate the people's will and force to fight. There, he took a bow in front of the national socialist policy

agenda. In this period of time, all landscapes were included into a special concept which reflected racial ideas of a Germanic superiority and economic ideas of autarchy, the theory of blood and soil (Blut-und-Boden-Theorie). Rubner did not refer literally to this concept, but some of his principles can only be understood in the national socialist context that combined cultural and military rearmament. Rubner applied concepts of "forest functions" (p. 472), "meanings" (ibid.), "tasks" (ibid.) and "effects" (ibid.) of forests. At first sight his treatise looks concise but in fact it lacks a coherent logic. Terms and meanings are mixed up and used as synonyms. But he can take credit for having introduced the terms into the scientific discussion. His treatise is summed up by a concept of seven "forest functions" (p. 473), including ethno-cultural, national cultural, national economic, military economic and technical, ethno-political and social functions.

Forest functions in the period of reconstruction after World War II

Victor Dieterich approached the forest-function-doctrine in 1953.[xiii] He described the interactive system between forest and man using the terms "benefits", "welfare benefits", "effects" and "functions". Dieterich applied "benefits" and "effects" synonymously. To Dieterich, benefits ("Leistungen") are natural effects of forests like wind deceleration. These "benefits" become "welfare benefits", when they fulfil a societal demand, p. ex. wind protection. According to Dieterich, the societal demand is called "forest function".

The benefits or effects of a certain forest are depending on the characteristics of the forest and changing by and by. The natural effects which interact with human needs are named welfare benefits (*Wohlfahrtswirkungen*) (p. 234). On part of these welfare benefits is the resource-function (Rohstoff-Funktion), which supports society with forest-products. The function-doctrine differs from the job-function (*Arbeits-Funktion*), the income-function (*Einkommens-Funktion*) and the capital-function (*Vermögensfunktion*). In addition, Dieterich described the area-function (*Flächen-Funktion*) which includes all other forest-functions like water, soil, climate, emission-control, nature conservation or recreation. Within this area-function he included a protective effect of forests (*Schutzwirkungen des Waldes*). There is no stringent differentiation of the used terms. Dieterich integrated the whole forest-function-concept into the idea of welfare benefits (*Wohlfahrtswirkungen*). He subsumed the protective effect of forests in three groups: 1. influence of the climate, 2. impact on water balance and erosion and 3. non-material benefit for man (p. 234). The individual functions are not independent but interconnected. Trade-offs might occur. The pursuit of each single function might challenge another function. Conflicts between different functions are identified among the resource-function (*Rohstoff-Funktion*) and the area-function (*Flächen-Funktion*). Problems are caused by restrictions for the forestry in difference to the social services ("Wohlfahrtswirkungen"). At the same time like Dieterich, Richard E. McArdle, a Chief of the US Forest Service and professor of forestry, described the multifunctional forest use as a coexistent preparation of different products and benefits at same area. McArdle could also rely on his previous scientific work.[xiv]

The forest-functions to the industrial society

Geared to Dieterich, Hubert Rupf, president of the state forestry in Baden-Württemberg, discerned in 1960 the resource-function (*Rohstoff-Funktion*), the receipts-

function (*Einnahme-Funktion*) and the reserve-function (*Reserve-Funktion*).[xv] Furthermore he named the job-function (*Arbeits-Funktion*), the protective-function of the forest (*Schutz-Funktion*) and the social-function as very important to human well-being. Like Dieterich, Rupf used the term social services (*Wohlfahrtswirkungen*) and supposed the different kinds of protective-functions for climate, water and soil. Rupf argued, that in 1960 social services would follow in backwash of a common forestry but in the years to come they would become an integral part of forest and landscape planning. This forestry operated with the view to a maximum clear profit. This perception was termed as "backwash-theory" (Kielwassertheorie) (p. 549).[xvi]

Eight years later, Karl Hasel (1909 – 2001), professor of forest policy, history and nature conservation in Göttingen analysed the future perspectives for the German forestry within a modernist industrial society.[xvii] The protective and the social function (*Schutz- und Sozial-Funktion*) of forests would become more and more important and finally subdue the resource-function (*Rohstoff-Funktion*). On the annual German forestry meeting of 1968, Hasel designated the primacy of the resource-function and the income-function (*Einkommens-Funktion*) as not longer up to date. Even though he only took up notions that other foresters already had some years earlier[xviii], it was a hard threat to most German foresters who witnessed the importance of wood during the Second World War and the post war period.

To Hasel, the social services of forests are no secondary effect of a regular silviculture but seen with the eyes of industrial workers, the most important effect of forests. Hasel stated that the resource-function (*Rohstoff-Funktion*), the protective-function (*Schutz-Funktion*) and the recreation-function of forests should be equal contents of the current forestry (p. 36). The regional German situation requires the implementation of all forest-functions at the same area and at the same time. But the importance of the various functions could differ.

Hasel's memorandum could be seen as the beginning of the German concept of integrative multifunctional forestry. He identified a couple of tasks like timber-production, landscape planning and human well-being. To him, not all kind of the many forest benefits would be countable in timber or economic profit (p. 55). This was a truth hard to take for regular foresters of his time. Not only had that most of them seen the importance of wood during the period of the German post war recovery, but also his concept devaluated the economic output of their everyday work. A shift from wood production to recreational activities meant more or less the giving up of forestry the way as they knew it. They deeply feared a professional degradation. Therefore, Hasel's thesis was hard contested.

But things are never as bad as they seem. The first guideline for mapping protective- and recreation-functions in forests appeared in 1974. Its intention was the sustainable protection and increase of all benefits of forests. This could be seen as a compromise between Hasel's position and the traditional view. In connection with the protective- and recreation-function August Henne (1921 – 2006), a Hessian forest scientist, used the term 'infrastructural benefit' of the forest.[xix] This concept was used to map German forests, although there were antagonisms between the terms social-function (*Sozial-Funktion*), immaterial benefit (immaterielle Leistung), social services

(*Wohlfahrtswirkung)* and the comitative effects (*Komitativwirkung*). The idea of integrative multifunctional forestry was fixed in the first German guideline for mapping the forest-functions. Generally, the satisfaction of multiple functions was expected in one single forest with one silvicultural activity (p. 13), which makes again for a conflict in pursuing each single function. The approach of the guideline separated a couple of tasks of the forest which are inseparably connected with a distinct silvicultural activity. The guideline distinguishes the three columns of sustainable forestry: resource-and-economy (*Rohstoff- und Nutzen*), protection (*Schutz*) and recreation (*Erholung*). Potential conflicts are not specified in view of the economic-function (*Nutzfunktion*). The economic-function is assumed on the whole forest area and not regionally specified. The German guideline integrated the water pollution control, the soil conservation, the avalanche protection, the climate protection, the emission control, screen-forests, protection of roads and protected forests for cultural or ecological aims in the term of protective-function (*Schutzfunktion*). Additionally, the German forest function map (*Waldfunktionenkartierung*) contains other legally protected areas. Forests with a focus on recreation activities are related to the recreation-function (*Erholungs-Funktion*). The second edition of the German guideline for mapping protective- and recreation-functions in forest was published in 1982 and remained almost unmodified up to now.

One year later the economic-function, the protective-function and the recreation-function were co-equally integrated in the first German federal forest act (*Bundeswaldgesetz*) (BWaldG, § 1, BGBl. I, S. 2585) as they were mentioned in the guideline earlier. This law followed a couple of federal laws, which dissented since 1949 from the one-side focus on the economic-function. The federal forest act's aim is the preservation and increase of the forest with the objective of a sustainable preservation of the three named and listed functions. Mentioned are in detail the ecological environment (*Umwelt*), the ecosystem (*Naturhaushalt*), the climate (*Klima*), the water balance (*Wasserhaushalt*), pollution control of the air (*Luftreinhaltung*), the soil fertility (*Bodenfruchtbarkeit*), the landscape (*Landschaftsbild*), the agro- and infrastructure (*Agrar- und Infrastruktur*) and the recreation (*Erholung der Bevölkerung*). Therefore the law demands the sustainable correct forest management (*ordnungsgemäße Waldbewirtschaftung*).

The current guideline (2003) for mapping protective- and recreation-function in forest contains nearly the same functions of the initial version of 1974. In addition to the term "function" Helmut Volk and Christoph Schirmer, two forest scientists, uses the term benefit[xx] (*Leistungen*). The principle demands to save all benefits of the forest by a sustainable silviculture. Effects (*Wirkungen*) of the properties of forests are described for each all mentioned forest-functions (*Waldfunktionen*). Diverging from the guideline's first version, now potential conflicts between the different functions are identified. The economic-function is still assumed for the whole forest area. Using the example of the forest guideline of the federal state Brandenburg the conceptual confusion becomes apparent. The Brandenburg guideline declares that forest functions (*Waldfunktionen*) are the effects of the forest (*Waldwirkungen*) which are used for the service to the public

(*Daseinsvorsorge*) (p. 8). They differentiate in economic-, protection- and the recreation-function (*Nutz-, Schutz- und Erholungsfunktion*).

Protagonist	Year	Occupation	Issue
Zwierlein, K. A.	1807	Spa doctor in Bavaria	Influence of forests on culture and happiness of states
de Jonnès, M.	1825	Explorer, statistician in France	Memoires sur le déboisement des forêts
Dieterich, V.	1953	Professor of forest policy inMunich	Definition of forest functions
Lehr, J.	1887	Professor of national economics	Denial of any forest function beside the economic function
Rubner, K.	1943	Ministry officer of silviculture and dean of the forest faculty in Eberswalde/Berlin	Tasks of forestry
Eberts, H.	1932	Prussian forest government and chair of forest policy and forest administration	Tasks of forestry
McArdle, R. F.	1953	President of U.S. state forestry	Multifunctional forest use as a coexistent preparation of different products and benefits at same area
Rupf, H.	1960	President of the forest government of Baden-Württemberg and head of the forest research institute Baden-Württemberg	„Backwash-theory“ („Kielwassertheorie“)
Hasel, K.	1968	Professor of forest policy, forest history and nature conservation in Göttingen	Importance of the protective and the social function in content of the future perspectives for the German forestry
Henne, A.	1974	Head of the forest research institute of Hesse	First guideline for mapping forest function
Volk, H. & Schirmer, C.	2003	Head of the department of landscape management and member of the department of forest ecology of the forest research institute Baden-Württemberg	Current guideline for mapping protective- and recreation-function in forest
Hockenjoos, W.	2007	Member of the forest government and the nature conservation organisation of Baden-Württemberg	Political and forestry trends to an increasing focus on the economic-function
Windisch, G.	2008	Director of the Bavarian forest government	The economic function is able to achieve all forest function in a sustainable way
Krott, M.	2009	Chair in forest and nature conservation policy in Göttingen	Consequences of the reforms of the German forest management for the forest services

Forest functions and the post-industrial society

Actually, the integrative multifunctional forestry is still propagated. But current political and forestry trends, including severe cuts in subventions are geared to an increasing focus on the economic-function. Wolf Hockenjos, a high ranking state forester of Baden-Württemberg and nature conservationist argued in 2007[xxi] that the multifunctional forester becomes a partial timber-producer (p. 21). The director of the Bavarian forest management, Georg Windisch,[xxii] president of the Bavarian state forests,

believed that the economic-function is able to achieve all forest function (p. 11) – in a sustainable way! In 2009, the forest political scientist Max Krott analysed the long list of reforms of the German forest management.[xxiii] To him, the reform-process of the recent years seems to have the objective of an economically efficient and market-oriented management. This could turn out to become a problem for forest-functions without a demand on capital markets (p. 13) e.g. for the 'classical' welfare functions.

Clear definitions of forest functions, tasks, and services

A long time multifarious terms are used to describe and explain the integrative multifunctional forestry. The articles contain the terms function (*Funktion*), use (*Nutzen*), protection (*Schutz*), social and recreation functions (*Sozial-/Erholungsfunktion*), tasks (*Aufgaben*) and effects (*Wirkungen*). All along the identified social requirements are nearly the same. Differences are explicit in the weight of the varying demands (*Ansprüche*). The meaning of the used terms differs between the issues, over the years and even inside a publication. Based on the specified concepts we will try to develop a consistent idea to understand the relationship between man and forest.

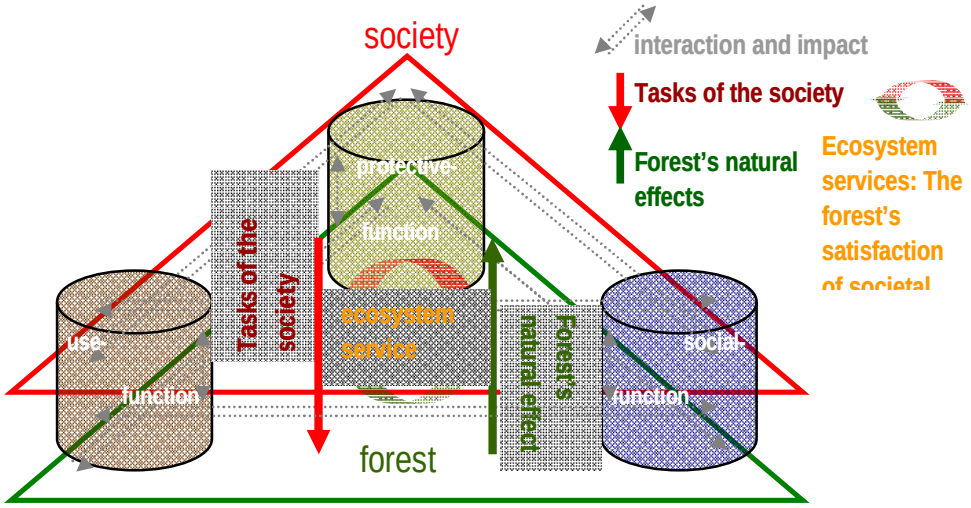

Fig. 1: Ecosystem services as the societal tasks satisfied by forest's natural effects. A concept of understanding integrative multifunctional forestry

Figure 1 shows our concept of ecosystem services in forestry. It gives a picture of forest-effects in context of understanding the German idea of integrative multifunctional forestry. Here, the economic-function, protective-function and the social-function are equal aspects of the triangle of sustainable silviculture. Nevertheless, conflicts may occur between and within the three columns which are caused by dependencies and interactions. Each society has demands to forestry. The demands change by and by. However, forests produce natural effects. These are limited by the ecosystem and the characteristics of each distinct forest.

As could be proved in this essay, the forest functions very often are named 'tasks', 'benefits', 'effects' and 'social services' or 'welfare benefits'. We suggest that a society's demands to a forest should be named 'tasks' of a forest. If the forest is producing 'natural effects' (or synonymously 'natural benefits') that make it possible to satisfy these demands, we should talk about 'services' that are delivered by the forest,

whereas the term ‘welfare benefits’ describes the same but seems to be old-fashioned today. This link of a forest’s task and service can be called an ‘ecosystem service’ like discussed in the millennium ecosystem assessment.

Conclusion

For about 120 years forestry is constantly losing ground in economic terms. Once being the main source of income to the state, German forests lost their economic importance step by step to the industry and later to the third sector. War-time recoveries were a flash in the pan (Bader 2009; Bader 2010).[xxiv]

Forest functions, tasks, and services give a meaning to forestry that goes beyond sheer wood production. They place forestry within the society and its needs, thus allowing the hope for remuneration of forests and forestry beyond wood selling. Scientifically, they link natural science dominated forestry science with humanities and social sciences. The professional background of scientists who developed the concepts of forests functions in the last hundred years shows that inter- or at least transdisciplinary working scientists who look beyond their own scientific horizon prevail. Therefore the conclusion is that research on landscape and forest functions is done at best in an interdisciplinary mode. Nevertheless, the long-lasting discussion involved many synonymous and inconsistent terms. Therefore, our model states as follows:

A society assigns ***tasks*** to forests and forestry. Forests produce ***natural effects***. If these effects satisfy the tasks, we should talk about ***forests’ ecosystem services***.

Notes

[i] For the concept of both inter- and transdisciplinatity, we rely on the defintions given by Krott, see Krott, Max: Umweltgeschichte durch starke Disziplinen – Vom richtigen und falschen Einsatz der Interdisziplinarität, in: Reeh, Tobias; Ströhlein, Gerhard; Bader, Axel (Ed.): Kulturlandschaft verstehen. ZELTForum - Göttinger Schriften zu Landschaftsinterpretation und Tourismus - Band 5, Göttingen 2010, pp. 25 – 38.

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Axel Bader is Research Assistant in Georg-August-Universität Göttingen, Büsgenweg Göttingen, Germany and holds the Chair of Forest and Nature Conservation Policy and Forest History.

Christoph Riegert is a PHD student in Nature Conservation and works for the Bavarian Forest State Forest Service in Regensburg, Germany.