

Forests' contributions to SDGs: an overview and examples from Switzerland for integrated approaches in anticipation of future changes

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Abstract

Some contributions of forests to Sustainable Development Goals (SDGs) are readily acknowledged such as CO₂ sequestration, biodiversity conservation and livelihoods. Our overview reveals a wider variety of possible interactions between forest ecosystem services and all the SDGs. While forests should be seen as an asset to be integrated into the sustainable development agenda, it is difficult to deliver such straightforward and powerful messages beyond the forest realm. Recognizing the need to better integrate forest contributions into wider policies, Swiss examples are presented through the current role of forests in the national sustainable development agenda as well as through its international forest development aid. Key elements supporting the integration of forests in other sectoral policies as well as ways of improving communication on forest ecosystem services are found to be similar across the globe. The paper concludes that traditional forest development and management strategies, which provided some of the most ancient nature-based solutions to societal needs, can provide useful lessons to the sustainability agenda. It points out that improved science-policy dialogues and cross-sectoral prioritization for action (in other words knowledge to action) can be seen as vital stepping stones. These are needed to link contributions of forests to the service of other sectors and to an accelerated implementation of the SDGs. All forests' contributions to the implementation of the Agenda 2030 should be acknowledged now and integrated forest adaptation strategies can serve as models in the face of climate change and in anticipating the future.

Keywords: SDGs, forest ecosystem services; network analysis; integrated forest management; adaptation to climate change

Introduction

After several episodes of natural hazards, notably floods, what would later be called forest ecosystem services (later abbreviated 'FES') were acknowledged already in the 19th century in Switzerland. Forest 'functions' were defined, anchored in the Swiss Constitution and most of them are now spatially defined for the whole country. Started during the era of technical assistance to developing countries, a Swiss tradition of support to social forestry and sustainable management has taken place since the 1960s, ranging from field activities to international policy dialog. Swiss international aid now focuses, amongst others, on supporting adaptation to climate change in mountainous and forested areas (Swiss Confederation 2020). In policy debates, forest governance (Colfer and Capistrano 2005) as well as integrated forest management approaches (Angst 2012) have been crucial interest and competency areas for Switzerland to share internationally.

Table 1: Historical perspective of Swiss forestry

Time period	Mid 19th - Mid 20th	1960-1990	1990-2020	2020-2050?
Triggers of change	Natural hazards	Wood economy	Nature conservation	<i>Climate change</i>

Policy framework	Command & control	Market-driven	Control, markets & targeted subsidies	<i>Combined tools for sustainable development?</i>
Priorities	Forest conservation & regeneration	+ wood quality	+ FES for population	<i>+ services for adaptation (for nature itself)*</i>
Economy	Resource for livelihoods	Resource for markets	Support to forest owners & for FES	<i>Support to owners, local population & global issues</i>
Planning system	Individual -> controlled	State-led -> local participation	Local participation -> Global services	<i>?</i>
Financing	Private	Kielwasser theory (private supports public)	Subsidies (public supports private)	<i>?</i>
Innovations	Peak in concepts & "action research"	Wood exploitation	Owners' organization	<i>New peak in concepts & "action research"?</i>
Management conditions	Minimal	Sustainable yield	Sustainable functions	<i>Resilience?</i>
Swiss support to global forests		Technical aids -> social forestry	Social forestry -> integrated programs	<i>Forests for sustainable development?</i>

*See Lavorel et al. 2020 on ecosystem services for adapting to climate change.

The SDG framework offers nowadays a truly integrated way of figuring sustainable development and represents an opportunity to investigate the role and contributions of forests to the 17 intervention areas.

With regard to climate change effects and the current societal need of an ecological transition, the objective of this article is to analyze and understand, from a Swiss perspective, i) what can be learnt from examples of multifunctional, integrated, and sustainable forest management approaches , ii) the way forests contribute to sustainable development along the SDG targets, and iii) the planning and communication potential that the knowledge of forest contributions to SDGs, and interactions among forest ecosystem services might have on future forest-related actions and policy dialogs.

Methodology

Overview of the Swiss forestry history and integration principles

This paper offers the authors' descriptive history of Swiss forestry in Table 1 and gathers a selection of pertinent papers and statements that explain why Switzerland can be described as a country traditionally planning forest management in an integrated way, i.e. in ways that consider multiple forest objectives, but with important implementation variations: from a territorial to a single-tree perspective (Küchli 2013). This descriptive part is not an exhaustive literature review but relates to key documents providing the perspective of the Swiss framework within the following SDG-forest analysis.

Analysis of the importance and interactions of forest ecosystem services

The 2030 Agenda for Sustainable Development and its interdependent 17 SDGs are the current global framework that guides policy-making on sustainability issues. Forests and SDGs were studied by Katila et al. (2019) for the effects of SDGs on forests. Since its premise, many authors have stressed the need to account for the systemic dynamics between potentially conflicting areas of development (Griggs et al. 2014; Le Blanc et

al. 2015). Some studies use network analysis techniques to identify policy-relevant insights and knowledge-based guidance in terms of governance (Pham-Truffert et al. 2020; Weitz et al. 2017).

This knowledge on systemic dynamics is context-specific. In the 2030 Agenda, States have common but differentiated responsibilities. Thus, this study investigates forests' dynamics with the SDGs both at Swiss and global levels, in order to enable comparison between the two.

Building on existing lists of contributions of ecosystem services (United Nations et al. 2021, Haines-Young and Potschin 2017), the authors identified a total of 14 provision, regulation, and cultural services which forests potentially offer to the 169 SDG targets of the 2030 Agenda. A survey was sent to a group of 10 forestry experts in order to evaluate the importance of FES to each SDG at Swiss and global levels. They assessed the overall importance of FES to each of the 17 SDGs, as well as the importance of specific services to them, using a scale ranging from 0 ("No special relevance") to +3 ("Crucial"). Tables 2 and 3 in the results section present the mean scores obtained at both levels.

In a second stage, the same group of experts filled a cross-impact matrix on how the ten FES, prioritized during the first stage, impact each other positively or negatively. Based on the sum of the interactions, identified as trade-offs or co-benefits, the authors obtain a network of FES and map the potential systemic multipliers and buffers (see Figures 1 and 2, adapted from Pham-Truffert et al. 2020). The x-axis represents the activity ratio of the services, that is, the ratio between the weighted out- and the weighted in degree in network terms. It maps the most positively or negatively influential services on the right ("multipliers") and the most influenced ones on the left ("buffers"). The y-axis represents the interconnectedness of the services, namely its weighted degree.

Results

Examples and potential lessons learnt from Switzerland

In Switzerland, policies in reaction to natural and economic issues have directly driven forests' sustainable management and an increasing integration of various FES. The willingness to consider in a relatively equitable way forests' functions (wood production, natural hazard protection and societal function) has led to diverse planning methods and silvicultural practices targeting multifunctionality. Nowadays, forest functions have been prioritized and mapped at the cantonal level. The integration of wood production and conservation has been particularly studied and practiced (Krumm et al. 2020). This long tradition led to Swiss forestry being considered as a valuable "Swiss story" to share (FDFA 2021).

Knowledge-to-action networks between Swiss foresters have been fruitful recently, for instance, in anticipation of adaptation needs. Previously unknown situations, such as dying beech stands, are being observed by practitioners and scientists. On the ground, innovative silvicultural interventions are needed. .

However, Swiss forests are adapted to climate change to varying degrees, principally due to different management histories. While diversified stands are facing the effects of new conditions, some remaining lowland monocultures, initially dedicated to wood production, are suffering from pests and climatic effects. After the sudden impacts of the 2018-2019 droughts, decentralized political interventions requested a focus on the adaptation of forests to climate change. For this new priority, scientists suggest adaptation measures that target structurally and functionally diverse forests (Brang et al. 2016).

The concept of integrated forest planning is nowadays challenged by a growing diversity of required FES and a rapidly changing environment. Useful Swiss practices to share might be linked to several successful silvicultural practices as well as to the functioning of the foresters' networks that allowed close interactions between practitioners, scientists and the federal administration.

Communication on forests' contributions to people and sustainable development

In Switzerland, stakeholders' involvement has long been dependent on the openness of State foresters and forest owners. Actual participatory approaches have been implemented since the 90s in regional planning processes. Nowadays, State or communal foresters remain pivotal in informing forest owners (HAFL 2021).

At policy level, the integration of forests in climate or water strategies is complex, as the focus is prioritized on the main issues (CO₂ emissions, pollution) rather than to reward already relatively good services. On the sustainable development side, as anchored in the 2030 national strategy, an active communication and implementation strategy has been put in place and is efficient. Unfortunately the linkages between forests and SDGs are hardly mentioned.

Internationally, Switzerland's specific experience in sustainable forest management, proactively shared in international discussions, included decentralized cooperation, near-natural forest management and preservation of the total forested area (FOEN 2021). Switzerland notably promoted applied solutions for the combination of wood production and biodiversity conservation within the European INTEGRATE network.

Forests and SDGs linkages evaluated from a Swiss perspective

Overview analyses: relative importance of forest services

Tables 2 and 3 give an overview of the assessed importance of forests' contributions to each SDG, at Swiss and at international levels respectively.

Table 2: Ranking of forest contributions to the SDGs in Switzerland

Degree of importance (0-3)	SDG	Service(s) assessed as the most important for the given SDG
2.75	SDG 6: Water	Regulation of water cycle
	SDG 13: Climate	Climate regulation
	SDG 15: Ecosystems	Nature protection
2	SDG 7: Energy	Climate regulation
1.75	SDG 3: Health	Recreation
1.5	SDG 14: Oceans*	Regulation of natural cycles
1.25	SDG 1: Poverty	Wood production and employment; Protection against natural hazards; Regulation of natural cycles
	SDG 2: Hunger	Regulation of natural cycles
	SDG 11: Cities	Climate regulation
	SDG 12: SPC	Wood production and employment
	SDG 17: Partnership	Nature protection
1	SDG 4: Education	Training, research
	SDG 8: Growth	Protection against natural hazards
	SDG 9: industry	Wood production and employment
0.75	SDG 16: Peace	Culture and heritage
0.5	SDG 5: Gender	Provision of NTFP
	SDG 10: Inequality	Recreation

*Interpreted here as "life below water" by experts

As expected, the only goals directly related to forests - SDG 15, "life on land", comes first according to the experts' evaluation. However, forest contributions to SDG 6 (water) and 13 (climate) are considered as

“crucial” (2.75). Situated at the second ranked level, one can note the “very important” (1.75 - 2) FES dedicated to energy production and health.

The group of experts gave lesser importance (1.25-1.5) to forests’ contributions to the other goals, such as “life below water”, poverty, hunger, cities, sustainable production and consumption (SPC) and partnerships (1.25). Even less important (1) were found to be those to education, growth and industry. Finally one can perhaps consider forest contributions to gender and equality as secondary for Switzerland.

Table 3: Ranking of global forest contributions to the SDGs

Degree of importance (0-3)	SDG	Service(s) assessed as the most important for the given SDG
3	SDG 13: Climate	Climate regulation
	SDG 15: Ecosystems	Regulation of natural cycles; Nature protection
2.67	SDG 6: Water	Regulation of water cycle
2.33	SDG 1: Poverty	Provision of NTFP; Regulation of natural cycles
	SDG 7: Energy	Wood production and employment
	SDG 17: Partnerships	Climate regulation; Nature protection
2	SDG 11: Cities	Recreation
1.67	SDG 2: Hunger	Provision of NTFP
	SDG 3: Health	Regulation of water cycle
1.33	SDG 8: Growth	Climate regulation; Nature protection
	SDG 12: SPC	Climate regulation
	SDG 16: Peace	Nature protection
1	SDG 4: Education	Training, research
	SDG 9: Industry	Wood production and employment
	SDG 10: Inequality	Provision of NTFP
	SDG 14: Oceans	Regulation of natural cycles
0.33	SDG 5: Gender	Provision of NTFP

The podium observed in Switzerland is conserved at the international level: FES for life on land (SDG 15) and climate mitigation (SDG 13) get the maximal note of 3 while FES for water (SDG 6) gets 2½. Similarly again, forests play a very important role in producing energy (SDG 7), but very differently from Switzerland: they are considered equally as important (2.33) to alleviating poverty (SDG 1) and to fostering partnerships (SDG 17). The important contribution of global forests to poverty reduction is linked in priority to the provision of NTFPs and the regulation of natural cycles.

Forests are further seen to play a prominent role for cities (SDG 11) and, in a slightly lighter manner, for hunger (SDG 2) and health (SDG 3). At 1½, contributions to growth, SPC and peace are classified as important but not highly ranked, while contributions to education, industry, equality and oceans were ranked at the low level 1

The prioritized FES are considered to be at least “important” (value 1) for all SDG targets with the exception of gender, inequality and peace for Switzerland, and only gender from the global perspective.

Interactions amongst FES



Fig. 1: Multipliers and buffers in the Swiss context. a) Climate regulation; b) Culture and heritage; c) nature protection; d) Protection against natural hazards; e) Provision of NTFP; f) recreation; g) Regulation of natural cycles; h) Regulation of water cycle; i) Training, research; j) Wood production and employment

Three groups of systemic roles seem to be revealed by Figure 1 for the Swiss context. First, the contribution of climate regulation (a) is evaluated as highly interconnected and able to play a multiplier effect of positive impact to other services in the Swiss forests. Similarly, training and research (i) can also positively impact the other services, despite being less connected in the system. However, both services can be negatively impacted by the prioritization of other services.

Second, regulating services - nature protection (c) and natural cycles including water (g and h) - and the protective function (d) form a relatively compact group of moderately interconnected and moderately active services in terms of co-benefits.

Finally, although provisioning services - wood (j) and NTFPs (e) - are not strongly connected in the system, they can largely benefit from the prioritization of other services. Yet, in terms of trade-offs, they can represent potential risks to other services. Culture and heritage (b) and recreation (f) also generate potential trade-off relations in the system. This could be explained by the fact that (over-)exploiting the resources provided by forests can be detrimental to its other services. In the Swiss context, culture and heritage is considered to contribute to peace (SDG 16) and recreation to health (SDG 3).



Fig. 2: Multipliers and buffers globally. a) Climate regulation; b) Culture and heritage; c) Nature protection; d) Protection against natural hazards; e) Provision of NTFP; f) Recreation; g) Regulation of natural cycles; h) Regulation of water cycle; i) Training, research; j) Wood production and employment

The evaluation of interactions amongst global forest services apparently shows a similar pattern of highly interconnected co-benefits and some tradeoffs that can act as multipliers. However, while only climate regulation (a) was highly interconnected in Switzerland, one finds at the same level of interconnectedness, globally, a group including training and research (i), forest water services (h) and the regulation of natural cycles (g). Interestingly, their related tradeoffs do not seem problematic, except for regulation of natural cycles (g) which was found by two experts to possibly negatively impact wood production (j).

Like in Switzerland, wood production (j) is mostly a systemic buffer, for better or worse, as it is impacted by the other services in the system. Recreation (f), contributing to cities (SDG 11), can be positively impacted by the other services, and in rare instances, can potentially negatively impact the system, such as when it impedes wood production (j) or nature protection (c), as two experts reported.

Discussion

Applied method

The ranking process helped to get a rapid overview of participants' perceptions of the contributions of forests to SDGs. The evaluation of the interactions by pairs of forest services was experienced as being much more challenging by the participants. Issues may come from the theoretical generalization of FES and from the fact that "all can be context-dependent". Moreover the relatively small sample of experts gives a probably over-evaluated importance to outlying answers, especially in terms of trade-offs. Further investigation will be realized with the group of experts to identify ways of improving the process.

Forests' contributions to the SDG targets

If one wants to consider forest contributions from a systemic perspective, in this paper through the use of all SDG targets, it would be necessary to go beyond existing forest planning frameworks, even the multifunctional Swiss one that hardly allows a flexible and exhaustive consideration of FES.

The significance of wood provision was evaluated by experts as less important than regulation services, when highlighted as priority service. However, the ranking still fits to the “cascading use” adopted by foresters. This principle supposes to use wood for its best, i.e. for construction and furniture first, then for the industry and finally for energetic purposes. The contribution of wood production to the industrial sector follows together with other “secondary” services. From a global perspective, wood production appears only twice as priority service: very important for energetic uses and rather secondary for industrial transformation.

Contributions of forests to partnerships is perceived as “more than secondary” in Switzerland and even very important, through their contributions to climate change and nature protection, at the international level.

Interactions between prioritized FES

Forest regulation services (climate, natural cycles, water) as well as protection services play a major and interconnected role in terms of co-benefits in Switzerland. Natural forests, close-to-nature silviculture and a forest ground remaining as covered as possible support such services and positive interactions. Targeting climate-related services would lead to co-benefits. The SDG target 12.2 appeared at the same position in the multi-sectoral analysis of Breu et al. (2020). While provisioning services are less interconnected as well as less influenced, tradeoffs seem limited in Switzerland, meaning that this provisioning FES still could be realized but not as a priority goal.

Globally, the role of forests in training and research appears to have one of the best potentials for multiple co-benefits. Conversely, wood production looks rather risky in view of the evaluated interactions: the potential for trade-offs is more active and interconnected than the co-benefits, which may lead to cascading trade-offs.

With attention given to the limitations of this study, the use of such analyses look promising as basic information to launch and facilitate various policy dialogs (regulations, finance mobilization), especially by highlighting trade-offs and allowing prioritizations. Ways to define priorities amongst stakeholders are increasingly needed.

Possible use of the SDG framework in planning and communication in and from Switzerland

In the forestry sector of Switzerland, the combination of the current formally recognized functions with the broader ecosystem service concept is a present, and complex, task conducted by the Federal administration. Cross-sectoral communication remains a challenge at policy level, notably when launched from the foresters' networks. They face strong political actors and lobbies, for instance with energy or water partners, whose issues are acute and not always with a particular focus on nature-based solutions.

One looks forward to a new planning framework that would be more adaptive, more open (in terms of FES) and probably more participatory. The integration of forest issues in domains that are “by essence” integrated, such as economy, land use planning, statistics and especially sustainable development, could have a rebound effect when the latter domains' principles are followed by sectors more powerful than the forest one. In addition, a link to sustainable development could benefit from the current active trends of knowledge generation and initiatives for sustainable development in Switzerland. The awareness of the SDGs (and the systemic nature of sustainable development) is widespread to most of the population, as exemplified by the recent “2030 Agendas”, which has been formulated at all governance levels, including local communities, for sustainable development.

At the international policy level, SDG and forest processes have similarities. They are not directly integrated in the major legally binding conventions on climate, biodiversity and desertification, but they absolutely cannot

be overlooked for viable future options. In line with Timko et al. (2018), we believe that SDG and forest experts can develop synergies on ways to ensure policy coherence and a proper involvement of decentralized levels. From a process point of view, as well as from an applied research perspective, adaptive and multifunctional forest planning can be integrated in a landscape (or land use) jurisdictional scale with other land-related dynamics.

Conclusions

Influenced by an initial “command and control” model, Swiss examples of integrated forest management and planning approaches benefit from a long tradition of combining different forest functions as well as efficient knowledge-to-action foresters’ networks. They have maintained a good collaboration and highlight now the need for diverse forests and stable stand structures. Global issues and climate change pushes us to think of transformational changes that reach beyond the forest realm. The forest-related knowledge, which has brought rich lessons learnt and best practices, will now not only have to adapt to climate change through new silvicultural management but also to the complex needs of the local as well as the global community through new processes.

The presented exploratory network analysis helps demonstrate general systemic perceptions, such as the growing importance of forest contributions to climate change and the prevalence of regulating services over provisioning services, including wood production. Interactions illustrated interesting and sometimes unexpected outputs, notably the role that forest ecosystem services could play for partnerships.

Forest and land use planning could in some cases act as a lever for sustainable development planning at various scales. Increased linkages between forest and sustainable development planning could certainly help involve the population and decision-makers and demonstrate FES and their effects on the broader needs for sustainable development. Such combined approaches could serve as models or frames for other complementary strategies in the face of climate change and in anticipating the future. In view of the uncertainties we are facing, the described systemic approach could support participatory prioritizations of pathways of change.

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