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Agricultural landscapes provide multiple functions – but how to assess them to support policy making?

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Agricultural landscapes provide several services and functions. Recognizing that we must not only focus on efficient food production, but optimally manage the trade-offs and synergies between these functions at landscape level is key in **our contribution to a sustainable food system** and related policy advice.

AIM

(1) Explore how the multifunctionality of agricultural landscapes is commonly analysed and examine the spatially explicit model-based approaches used to assess those.

(2) Investigate how linkages to the wider food systems are captured.

METHOD

We identified key elements for policy-relevant agricultural landscape assessments (Fig.1) and undertook a systematic literature review to assess ~100 publications with respect to these key elements.

The examined **MODELLING APPROACHES** quantified ecosystem structures and processes (Fig.2) and differed greatly in their parameterization. This involved both which specific abiotic, biotic, and management driving factors were considered (Fig.3) as well as how many.

Changed production patterns might impact distant ecosystems, resulting in geographical shifts of environmental burden. However, these **OFF-SITE EFFECTS** were neglected in the reviewed agricultural landscape assessments.

The interconnectedness of **CROP AND LIVESTOCK PRODUCTION** was rarely considered in agricultural landscape assessments. This applied to product and nutrient flows from crop to livestock production as well as in the reverse direction.

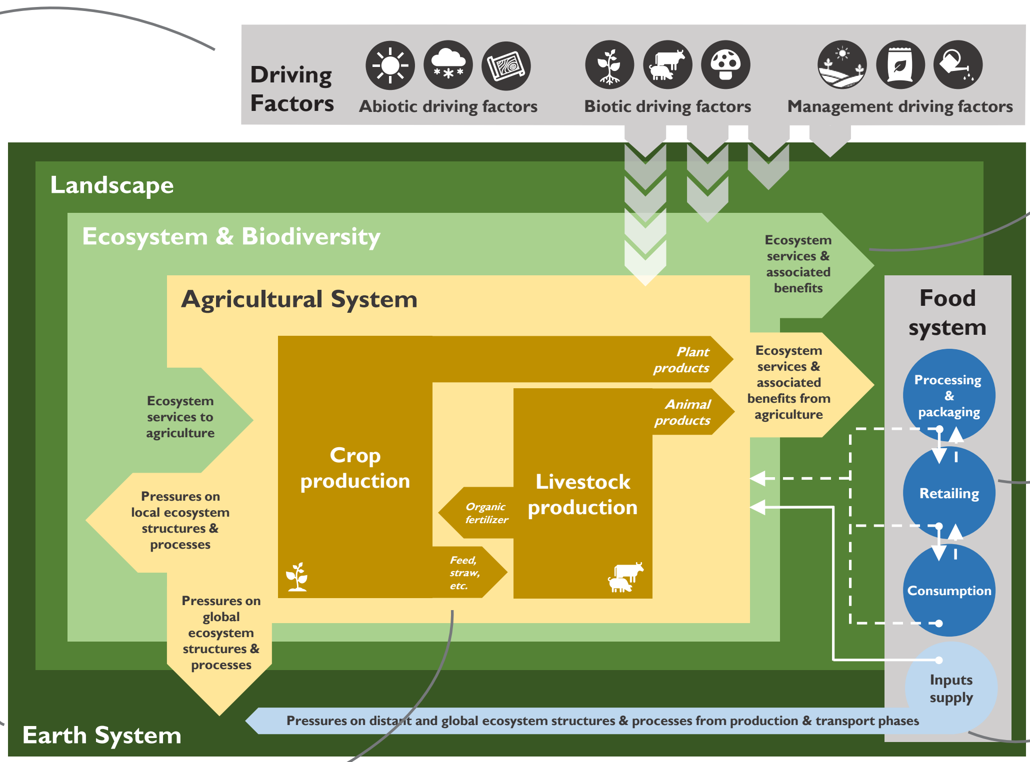

Fig. 1 Key elements for policy-relevant agricultural landscape assessments

Certain **ECOSYSTEM SERVICES** were covered extensively, while others were largely absent (Fig.2). Some were mutually exclusive; for example, biodiversity and water conditions were each assessed in about half of the publications, but rarely together.

WASTE AND BY-PRODUCTS are rich in nutrients and could be returned to the agricultural system in form of organic fertilizer or feed. However, these nutrient sources were only considered in a single reviewed publication.

Even though the use of **EXTERNAL INPUTS** is widespread in agricultural production, most reviewed publications did not consider the corresponding external impacts.

% of reviewed publications considering the specific ecosystem services and biodiversity.

Ecosystem structure and process variables computed to quantify respective ecosystem services (size of the bubbles relates to the number of publications).

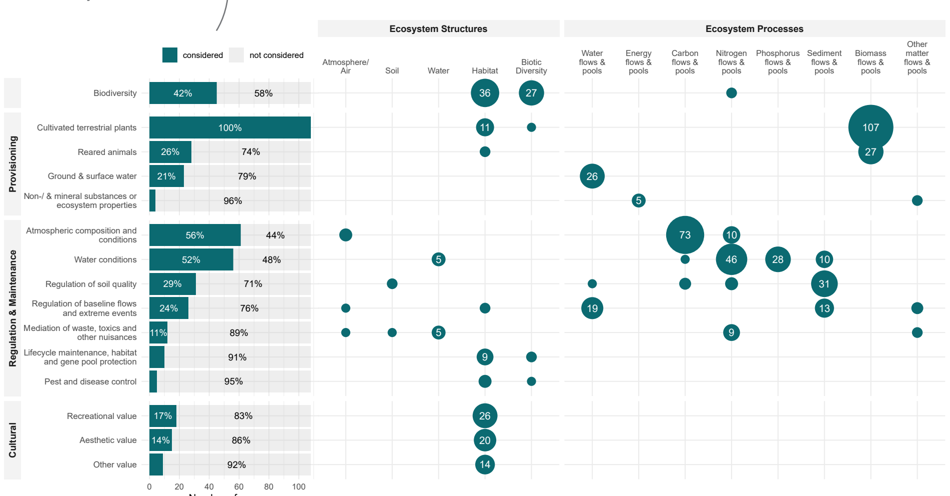

Fig. 2

Number of publications considering the respective ecosystem structures and processes.

% of publications integrating the specific driving factors in their modelling approaches

The total % of publications, considering the various driving factors at least once.

		Atmosphere /Air	Soil	Water	Habitat	Biotic Diversity	Water flows & pools	Energy flows & pools	Carbon flows & pools	Nitrogen flows & pools	Phosphorus flows & pools	Sediment flows & pools	Biomass flows & pools (Plants)	Biomass flows & pools (Livestock)	Other matter flows & pools	Total
		Ecosystem Structures					Ecosystem Processes									
Number of publications considering respective ecosystem structure/process		3	3	10	45	25	36	4	59	48	25	47	108	28	4	108
Abiotic driving factors	Climatic factors	33%	0%	30%	2%	16%	64%	0%	44%	58%	64%	53%	40%	7%	0%	69%
	Soil features	0%	33%	40%	0%	8%	61%	0%	51%	67%	72%	72%	49%	0%	0%	78%
	Topographic factors	0%	67%	50%	22%	12%	56%	25%	25%	46%	68%	72%	24%	7%	25%	65%
	Risk factors	0%	0%	0%	2%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%	6%
	Other abiotic factors	0%	0%	0%	2%	4%	0%	0%	3%	0%	4%	2%	0%	0%	0%	17%
Biotic driving factors	Plant physiological ecology	0%	0%	20%	2%	0%	25%	0%	29%	29%	20%	15%	52%	18%	0%	62%
	Animal physiological ecology	0%	0%	0%	0%	0%	3%	0%	2%	2%	0%	0%	0%	18%	25%	8%
	Ecological factors	0%	0%	0%	40%	56%	0%	0%	0%	0%	4%	2%	6%	0%	25%	31%
	Other biotic factors	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	1%	0%	0%	17%
Management driving factors	Land use/land cover	67%	67%	70%	87%	56%	72%	50%	63%	63%	64%	81%	77%	36%	75%	91%
	Crop production factors	0%	33%	40%	9%	12%	22%	50%	31%	65%	64%	47%	45%	14%	0%	68%
	Animal production factors	0%	0%	0%	2%	0%	0%	0%	8%	10%	4%	0%	0%	57%	0%	19%
	Landscape structure	0%	0%	0%	49%	16%	0%	0%	3%	4%	4%	11%	10%	4%	0%	32%
	Built environment/infrastructure	0%	0%	0%	13%	12%	3%	25%	2%	2%	4%	2%	2%	0%	0%	10%
	Risk factors	0%	0%	10%	2%	4%	3%	0%	2%	4%	4%	0%	2%	0%	0%	6%
	Socio-economic factors	0%	0%	10%	24%	0%	6%	0%	7%	4%	0%	4%	41%	54%	0%	50%
	Other management factors	0%	0%	10%	7%	8%	3%	25%	5%	2%	0%	2%	1%	0%	0%	17%

Fig. 3

CONCLUSION

Our preliminary results show that policy advice based on existing models may overlook trade-offs and synergies between landscape functions. They might further fail to reflect variations in relevant driving factors and food system linkages. Studies might therefore misidentify the levers for change and fail to show decision-makers the full scope for action. We thus suggest to adopt encompassing modelling approaches, hedging against overly costly data requirements by focusing e.g. on sensitivity analyses, allowing to identify leverage points for policy influence.

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