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Exploring the interdisciplinary potential of the Agenda2030—Interactions between five Danish societal demands for sustainable land use

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ABSTRACT

This article explores the potential of the SDG framework for interdisciplinary research. The aim is to illustrate the process of creating a shared platform of operation by the clarifying the positive and negative interactions between societal demands for land use on a national and local level. The research question is answered by making use of the systemic approach introduced by Niklas Luhmann including his arguments about autopoietic communication systems reproducing themselves. An interdisciplinary research group is firstly applying the SDG framework to the demands for sustainable land use by activating the land consolidation in Denmark. By doing so a 'national framework' anchored in the SDG framework is created. Secondly, the national framework is applied to a multifunctional land consolidation project in a Danish case area. The findings from the mapping of interactions between societal demands on a concrete case area revealed that some indicators and societal demands are more prone to conflicts than others but also on the local level there may be variations. Thus, a localised and contextualised SDG framework has shown useful insight for future projects on sustainable land use including land consolidation projects. The paper concludes that the SDG framework may be used for facilitating interdisciplinary research, however there is also a need for guidelines and examples on how to integrate the framework in academia. The paper offers a suggestion for integrating the Agenda2030 and the SDG framework in projects about sustainable land use.

1. Introduction

Based on demands for sustainable land use in Denmark we explore in this article how the Agenda2030 (UN, 2015) may facilitate interdisciplinary research and cross sectorial cooperation about sustainable land use. We take the point of departure in an empirical case and we apply theory on autopoietic communication systems introduced by Luhmann (2000). Since the UN adoption of the Sustainable Development Goals (SDGs) in Agenda2030 in 2015, nations and interest organisations have on a policy level worked on how to understand and apply the goals and targets in a national context and/or to a concrete situation. Less research has been published about the potential and implications of the SDGs and the agenda they are created upon in research and planning processes. Although interdisciplinary approaches towards sustainable development has been requested already in the Brundtland Commission Report (1987) research, planning and policy involving a sustainability perspective towards land use tends to be anchored in one or two academic disciplines or sectors. Moreover, introductions of interdisciplinary framework like the multifunctional land use in the late 1990's and later the ecosystem service approach support discussions of sustainability, interdisciplinary research in sustainable land use is often seen anchored in an traditional understanding of sustainable development as consisting of three separated pillars: the environmental, the economic and the social (ICSU, 2017). Rasmussen

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(2014) argues that challenges related to interdisciplinary research in academia partly are due to research funding and publication canals and partly because of the universities organizational structures and merit systems. This means that findings from for example rural studies about sustainable land use may focus on the social dimension of sustainability and are most likely to be applied by rural community spokes persons, the municipalities' rural development planners and rural development NGO's while findings from farm economy studies about sustainable land use most likely refer to the economic sustainability and are applied by farmers, agricultural policy makers and NGO's within agriculture and farming. One of the bigger challenges to overcome in interdisciplinary research is that different disciplines have developed specific academic language with terms and understandings of concepts that may not always be clear to other disciplines (Rasmussen, 2014). They have become what Luhmann (2000) terms autopoietic systems. That means self-reproducing social systems, which will always seek to reduce complexity outside the system by reformulating (decoding) part of the outer world, so that it fits in to the logic of the system. Thereby the system increases in complexity and the complexity of the outer world decreases (Luhmann, 2000).

In a case of clarifying interactions between five societal demands from the perspective of the five different disciplines, what would most likely happen is that each of the five disciplines would seek to reduce the complexity of the other four disciplines by reformulating concepts and terms so that they fit into logic of their own discipline. Along with this process there is embedded an element of power which is strongly linked to knowledge regimes. Interdisciplinary research on society-nature relationship regarding land use has often proved to be challenging to overcome especially the dualistic thinking in the development of a common communicating platform between disciplines (Smith, 2006) and the tensions and conflicts stemming from this dualistic thinking have to a great extent lead to the subordination or exclusion of the social and relational dimension on behalf of the bio-physical environmental and economic dimension of a sustainable development (Gerber, 1997; Vallance et al., 2012).

With this challenge as a background the normative research question we explore is: how does an application of the SGD approach contributes to interdisciplinary research, policy and planning on five national and local societal demands for sustainable land use? The aim of the paper illustrates the perspective of a research-based application of the SDG approach to concrete situations involving reallocation of land use and to illustrate how SDGs and targets may be translated into a national context and to an actual policy and planning situation and vice versa. The paper is structured so that the following section shortly introduce the SDG framework that we explore the application of. The next three sections explain the three steps of exploring a national and a situational application of the SDG's, followed by a discussion of the findings and concluding remarks.

2. The SDG framework for exploration

The SDG approach to sustainable development challenges the three-pillar sustainability tradition while also standing on the shoulders of the ecosystem service approach and the perspective of multifunctional land use (ICSU, 2017). Firstly, it points to the need for addressing multiple visions across academic disciplines and spatial scales in order to overcome the sectorial thinking while simultaneously accept that different academic fields have different methods and lean on different types of data (UN, 2019). Secondly, prioritizing and valuing societal demands for sustainable land use are usually done by policy makers (De Brucker et al., 2013). The International Council for Science (ICSU) argues however for the need for research-based attention to the interactions between such different goals for sustainable development so that policy and planning prioritization and decisions are anchored in science-based knowledge. They suggest that mapping of interactions between SDGs and targets should *'stimulate more science-policy dialogue on the importance of interactions, to provide a starting point for policy-makers and other stakeholders to set their priorities and implementation strategies, and to engage the policy community in further knowledge developments in this field.'* (ICSU, 2017:7). This argument is supported with concrete examples on actions in the recent report 'The Future is now - Science for achieving sustainable development' (Global Sustainable Development Report, 2019).

The ambition to create a stronger link between research-based knowledge in decision-making processes is also recognised by Gullino et al. (2018), who provides an example of this in their land use case about landscape qualities in Pralormo. Based on their findings they claim that landscape scenarios created upon the stakeholders' visions helps to anchor stakeholders' final decisions on land use in science-based knowledge. A similar argument is used in Netherland's model for land consolidation. In the model farmers/ landowners are asked to bring suggestions for sustainable production and the future landscape, participating in group-discussions, and at the same time with support from experts forming the landscape on a model, so that the stakeholders can see the impact (Hartvigsen, 2015). In this paper we follow up on the argument about the need for a stronger involvement of research-based knowledge in policy and planning decisions concerned with sustainable development, more specifically in the case of sustainable land use. Though it also suggests that attention should be directed at improving the ground for decisions for local initiatives among local citizens and farmers in rural settings. As it is pointed out by Knickel and Renting (2000) it is not enough to include societal demands from interest groups. Sustainable land use considers different geographical levels; for example, farm level, community level, regional level, national level, and global level.

It is this challenge we suggest to be addressed by Agenda2030 as it builds on an integrated approach, directing attention to the interactions between goals and targets and to the need for academia to involve in providing research based knowledge when applying the SDGs at national level as well as in situational local scales. Thus, we suggest understanding the Agenda2030 as a mind-set for creating radical positive transformational changes towards sustainable societies, with a number of specific tools embedded. The tools vary from the 17 Sustainable Development Goals with 169 targets and 244 global indicators connected to the goals, to a common vision and gathering narrative, strong interlinkages with the Human Rights framework, government commitments and an international review process (UN, 2015). Secondly, we also suggest to understand and use the four basic principles of Agenda2030 as tools that should be reflected in all efforts towards achieving and localising the agenda, regardless of which specific goals and targets are at the centre of one's effort. The four principles are: 1) Universality: The SDGs apply to all countries and hence all countries must take actions. As it has been phrased: "With the Sustainable Development Goals, we are all developing countries". 2) Leave-no-behind: None of the goals have been reached before they have been fulfilled for the groups furthest from reaching them - often the poorest and most marginalized people. 3) Sustainability: Human development should not be at the expense of our climate, environment and biodiversity, and 4) Policy Coherence for Development: Integrating the economic, social, environmental and governance dimensions of sustainable development at all stages of domestic and international policy making to ensure that efforts made to achieve one goal or target is not undermining the achievement of another goal or target (UN, 2015; UN, 2019). By using these tools to operationalise the SDG framework into practice at a national and local level we explore how the application of the SGD approach contributes to interdisciplinary research, policy and planning processes.

3. Step 1: applying the SDG framework to Danish societal demands for sustainable land use

Policy and planning for sustainable land use in Denmark can be seen

as an extreme and illustrative case (Flyvbjerg, 2001) of aligning national societal demands for sustainable land use with the SDG framework. First, the World Wildlife Fund (WWF) report on footprint points out that the Danish landscape and nature are under pressure as the global hectares demanded per person in Denmark are 6,8 ha, being in top of the EU (WWF, 2019).

The societal demands for future sustainable land use that are spelled out by Danish interest organisations and policy programs having stakes in land use in Denmark include: biodiversity conservation, rural development, sustainable farm economy, environmental management and outdoor recreation (Johansen et al., 2018a, 2018b). Such societal demands can be identified also in the EU agricultural policy programs (European Parliament and Council, 2013; Matthews, 2013).

In order to operationalise the SDG framework into practice at a national and local level, the first question to answer would be how national societal demands for sustainable land use are aligned with the SDGs and their targets. Answering this question calls for identifying the national indicators that should be used for screening and evaluating policy initiatives and projects that seek to integrate national societal demands for sustainable land use. Thus, on the basis on a literature review and researchers' expert knowledge five indicators within each of the five societal demands are suggested (Table 1).

When holding the five Danish societal demands for sustainable land use and the 25 associated national indicators against the 17 SDGs some of the five demands are easier to point out than others. The same counts for the 179 targets. While the three easier Danish societal demands to anchor among the 17 SDGs and 179 targets are *Farm Economy*, *Environment* and *Biodiversity Conservation,* all of the five Danish societal demands can be linked to the framework (See Table 2). The societal demand concerning *Farm Economy* is that sustainable land use includes that farming in Denmark should be economically sustainable and changes in land use should take this into consideration. Ways to increase the economic sustainability by changing the way the land is used are suggested by the indicators. When aligning the five Danish indicators for *Farm Economy* with the SDG framework this study found that *Farm Economy* addresses SDG12 'Ensure sustainable consumption and production pattern', especially target 12.2 about sustainable management and efficient use of natural resources for decreasing the ecological footprint by agricultural production. Further, improving agricultural productivity in a sustainable way supports SDGs improving rural livelihood, namely SDG8 and in particular target 8.1 and 8.2 about sustaining economic growth per capita and per employee. The Danish societal demand for sustainable development *Environment* is that freshwater, water surfaces and ground water should be improved as covered by the five indicators for *Environment*. This Danish societal demand for sustainable land use has a direct relationship with SDG6, target 6.3 improving water quality by reducing pollution and target 6.6 about protecting and restoring water-related ecosystems. A growing population with increasing needs for food will put pressure on the aquatic environment because of risk of increasing losses of nutrients, pesticides and other harmful substances from agricultural production. Furthermore, reducing the risk of pollution of groundwater and surface waters is in line with the SDG14, target 14.1 about preventing marine pollution from land-based activities. Finally, the target 15.1 about ensuring that the conservation, restoration and sustainable use of inland freshwater is in line with the international obligation under international agreements, which Denmark is part of. The Danish societal demand for sustainable land use *Biodiversity Conservation* associates to the SDG15 'life on land' halt biodiversity loss and target 15.5 which points to the urgent and significant need for action to reduce the degradation of natural habitat, halt the loss of biodiversity and protects and prevent the extinction of threatened species. Also, the societal demand *Biodiversity Conservation* is in line with target 15.9 and 15.9.1 about integrating biodiversity values into national and local planning. The societal demand *Rural Development* includes that sustainable land use should also take into consideration the rural population and ensure

Table 1
The five societal demands for multifunctional land consolidation and the indicators for each demand. The demands were formulated within a Danish Collective Impact initiative "The countryside as a double resource". See more about the initiative and a full explanation of the Danish indicators and the methods used in Johansen et al. (2018a, 2018b).[2]

Societal demands/ indicators	Rural development	Outdoor recreation	Environment	Biodiversity conservation	Farm economy
Indicator 1	Sense of community identity: locals organise common activities, locals feel a shared place attachment anchored in a common understanding of the culture on land use.	Public access: users have the right to roam the areas.	Nitrogen (N) emissions: To air (ammonia), groundwater (nitrate) and surface waters (reactive and organic N).	Designation: Areas of conservation interest are included	Soil quality
Indicator 2	Perceived quality of life: nearness to nature and easy informal and formalized access to landscape.	Recreational facilities/ trails: infrastructure supports recreational use of the areas.	Phosphorus (P) surplus and emissions: Balancing or negative P surplus for lowering legacy P and losses from soils to surface waters.	Protection: Areas of conservation interest are effectively protected.	Road transport; Fields closer to the farm buildings will reduce road trenaport.
Indicator 3	Social- and business- entrepreneurship: locals starts new business and social events.	Accessibility: users can get to the areas.	Surface water quality and ecology: Meet targets of good chemical and ecological quality.	Spatial continuity: Habitats are large and connected	Field shape and size; make field operations less time consuming.
Indicator 4	Socio-economic and demographic balance: people of different ages, educational background and work situation live in the locality.	User knowledge: the opportunities of the areas are known to the users.	Other substances – multi-pressures: Reduce losses of harmfull substances to groundwater and surface waters.	Restoration: Natural dynamics are restored	Regulation; reallocation of land may ease regulatory constraints.
Indicator 5	House prices: selling periods and prizes of the houses follow are on average the same as in rural areas in Denmark in general.	Recreational use: the areas are used by people.	Targeted mitigation and restoration: Mitigate against pollution at source and restore ecosystems.	Integration: Habitat friendly organization of agriculture and silviculture.	Flexibility; better land consolidation increase farmers robustness to meet future societal demands.

Table 2
Links between Danish societal land use demands and targets within the SDG framework.

Danish societal land use demand	Sustainable Development Goal	Target
Farm Economy	SDG12: 'Responsible Consumption and Production'	12.2: Sustainable management and efficient use of natural resources for decreasing the ecological footprint by agricultural production.
	SDG8: 'Decent Work and Economic Growth'	8.1: Sustaining economic growth per capita. 8.2: Sustaining economic growth per employee.
Environment	SDG6: 'Clean water and Sanitation'	6.3: Improving water quality by reducing pollution 6.6: Protecting and restoring water-related ecosystems
	SDG14: 'Life Below Water'	14.1: Preventing marine pollution from land based activities.
	SDG15: 'Life on land'	15.1: Ensuring that the conservation, restoration and sustainable use of inland freshwater are in line with the international obligation under international agreements.
Biodiversity Conservation	SDG15: 'Life on Land'	15.5: Urgent and significant need for action to reduce the degradation of natural habitat, halt the loss of biodiversity and protects and prevent the extinction of threatened species. 15.9 and 15.9.1: Integrating biodiversity values into national and local planning
Rural Development	SDG11: 'Sustainable Cities and Communities'	11.3 Integrated and sustainable human settlement planning 11.4: Strengthening efforts for protecting cultural heritages 11.8: Supporting positive links between urban and rural areas as a part of the national and regional development planning.
	SDG16: 'Peace and Justice Strong Institutions'	16.7: Ensuring responsive inclusive, participatory and representative decision-making.
Outdoor recreation	SDG4: Quality Education	4.7: Ensuring learning and skills needed for promote sustainable development.
	SDG3: 'Good Health and Well-being'	3.9: Reducing the number of illness from pollution

their living conditions and quality of live, which may be seen aligning with target 11.4 Strengthening efforts for protecting cultural heritages and target 11.3 about integrated and sustainable human settlement planning. Also, the demand *Rural Development* associates to target 11.A about supporting positive links between urban and rural areas as a part of the national and regional development planning. Finally, it may also be argued that some of the suggested Danish indicators for *Rural Development* link to target 16.7 about ensuring responsive inclusive, participatory and representative decision-making. The societal demand in Denmark for *Outdoor Recreation* as an element of sustainable land use meets target 4.7 about ensuring learning and skills needed for promote sustainable development. Also target 3.9 about reducing the number of illness from pollution associates to the Danish demand *Outdoor Recreation*. Table 2 summarizes the translation of the societal demands into the SDG's and their belonging targets.

With this mapping of alignment between the five Danish societal demands for land use and the SDG framework as a point of departure for the analysis, the step 2 is to follow up on the key principle in Agenda2030 of a coherent and integrated sustainable development by clarifying the positive and negative interactions between the five Danish societal demands for sustainable land use and the 25 belonging indicators.

4. Step 2: clarifying interactions between indicators for societal demands

4.1. A common platform for communication

While the first step basically could be carried out without any interaction between academic disciplines or planning sections, step two calls for interactions across disciplines and sectors. To create a common communication platform to support an integrated approach to sustainable development, the ICSU has developed a seven-point scale for classifying impact of interactions between the 17 goals and their associated targets. Thus, for being able to classify the impact each of the disciplines need to have a deeper understanding of what is behind the indicators defined by the other disciplines. The seven points scale includes impacts from interaction, which points out if the relations between targets are negative or positive. Negative interactions will in general indicate that action for fulfilling one specific goal will compromise another specific goal while positive interactions indicate that action for fulfilling one specific goal will have a positive impact on another specific goal. The seven-point scale goes from -3 on the negative side to + 3 on the positive side. On the positive side are the effects +3 indivisible, + 2 reinforcing and +1 enabling. On the negative side are the effects -3 cancelling, -2 counteracting and -1 constraining. The seventh point is 0, which refers to effect being consistent. To each of the points follows an explanation, which includes a geographical, a time, governance, a directional and a technology dimension (for a full description of the seven points, see ICSU, 2017: 23). ICSU (2017) makes it clear that the interaction between two goals may not be reciprocal and balanced. Impact can be unidirectional and bidirectional. An example of unidirectional impact is that A may affect B, but B does not affect A. Bidirectional impact between interactions is when A affect B and B affect A, however the affect may be more or less symmetric. Interactions may also employ more than two goals and be circular. For example, A affects B and this affects C which then affects A and they can be multiple: A affects B, C, D etc. Then, following Luhmann (2000) the communication about differentiation between interactions is highly complex and it puts - in the debate about societal demands for sustainable land use - pressure on each discipline for increasing the complexity of own discipline while at the same time creating a new communication system anchored in the seven point scale for evaluating interactions between goals and targets.

4.2. Applying the seven-point scale to five societal demands to land use in Denmark

For exploring the interactions between the five Danish societal demands for sustainable land use, firstly each discipline explained their indicators in a few lines and forwarded them to the other four disciplines. Secondly, based on the explanation given, each discipline went through all the explanations and graded the expected impact on the Danish societal demand for sustainable land use by making use of the seven-point scale. This part of the process gave each of the five disciplines an opportunity to decode the other disciplines and reduce complexity by increasing complexity of own discipline. Thirdly, an oral presentation of the gradings by each disciplines were given so that every involved researcher got an understanding of which impact a specific indicator for sustainable land use created, giving a common ground for understanding the interaction between one indicator for sustainable land use and the four disciplines representing the other

Fig. 1. Cards illustrating the explanations and interactions between five indicators and five societal demands for sustainable land use in Denmark.

societal demands for sustainable land use. This presentation and discussion process was repeated for all 25 indicators until a point of saturation was reached and a common communication platform was created. An important finding in creating the communication platform was the respect for context dependency. In line with the arguments from ISCU it became clear during the discussions that interactions

between some of the indicators may depend on the local context. Thus, rather than attributing a single score for some of the indicators it made more sense to attribute an interval so that it for example goes from 0 to +2, as is the case of the interaction between the indicator for *Biodiversity conservation* 'designation' and societal demand *Outdoor recreation*. A conservation initiative might be inaccessible to potential users due to the designation; hence the initiative does not influence recreation. Contrary, an easily accessible designation will improve recreational opportunities. The Fig. 1 are examples of the short explanation of an indicator within a discipline on one side of a 'card' and the other side of the card showing the interactions between the indicator and four societal demands.

The cards represent a common communication platform shared between five academic disciplines each representing one of the Danish societal demands for sustainable land use, while also representing a reduction of complexity of the other disciplines by increasing complexity of own discipline.

4.3. Creating an overview of positive and negative interactions between Danish societal demands for sustainable land use

For creating an overview of positive and negative interactions, the 100 interactions between the indicators for the five societal demands for sustainable land use in Denmark were summarized. This was done in two ways. One way was the "inside-out view" which assesses sustainable land use from each indicator and gives points to the impact on other societal demands if a demand is fulfilled with emphasis on the single indicator. The other way was the "outside-in view", which focuses on how indicators from other societal demands affect the societal demand in question. For example, to pay attention to how the indicators for rural development, biodiversity, outdoor recreation, and farm economy affect the societal demand for improved environment. Fig. 2 illustrates the interactions and the inside-out and the outside-in views.

The averages of positive and negative interactions for both viewpoints are illustrated in Table 3.

One finding from summarizing was that the societal demands 'outdoor recreation' is extremely asymmetrical in the sense that it has a neutral impact on other societal demands (average of 0.03) but fulfilling the other societal demands is synergetic to outdoor recreation with 0.75 on average. Another striking result is that all interactions are positive even though the result in Table 3 is the average of scores on a symmetrical scale around zero and this implies that irrespective of the view is from inside-out or outside-in then all societal demands have positive interactions on average.

Another quantitative summary is to count the numbers of positive and negative interactions and thus illustrating the distribution in the interactions, see Fig. 3. The societal demands *Environment* and *Biodiversity Conservation* both have a vast majority of positive interactions. *Farm Economy* is the research area with the largest variation in scores. The indicators in both the *Environment* and *Biodiversity Conservation* demands affect other societal demands positively in more than 14 out of 20 interactions and are the ones affecting other societal demands most positively. Summing up the *inside-out view* reveals more synergies than conflicts between the societal demands. Totally, there are 57 synergy interactions and 17 conflict interactions and the rest are neutral.

Synergies is on average more pertinent for *Farm Economy* and *Biodiversity Conservation* if efforts for sustainable land use is focusing on indicators of other societal demands, but less positive than what could be expected within *Environment*, *Outdoor Recreation* and *Rural Development*. The variation in the scores from the outside-in view can be illustrated by counting the scores presented in Fig. 4.

The negative interactions (conflicts) in the areas *Biodiversity Conservation*, *Farm Economy* and *Rural Development* are more frequent than in *Environment* and *Outdoor Recreation* (Fig. 4). For *Rural Development* are the numerous positive interactions (synergies) causing the average score (Table 3) to be high.

Summing up the interactions between indicators show much more synergistic than conflicting when scoring the demands for sustainable land use in Denmark.

5. Step 3: applying the contextualised SDG framework to a concrete policy and planning situation on sustainable land use

While the former two sections explored the aligning of five societal demands for sustainable land use in Denmark with the SDG framework leading to a common communication platform, this section explores the application of the created platform on a concrete project aiming at sustainable land use.

The project 'Land consolidation for sustainable land use' involves an area around Glenstrup Lake that covers approximately 150 km^2 being located in the municipality of Mariager Fjord. The area is dominated by agricultural land use, including small villages, hamlets and individual farm properties. There are approximately 530 households in the area, 15 bigger livestock farms with more than 100 livestock units,[1] and 63 bigger farm properties, each operating more than 100 ha farmland, are managing 55 per cent of the total land in the project area.

As part of the project it was decided to initiate a process, which included local citizens, farmers, NGOs, and different administrative sections in the municipality. Acknowledging the method outlined above, the process was planned as follows: 1) screen for project area for potential fulfilment of societal demands within each disciplines, 2) map the interactions between indicators and societal demands activated by the screening, and 3) present and discuss the findings with first the administrative sections of the municipality and present and next discuss the findings with the local citizens and farmers. The following three sub-sections illustrates the methods and findings.

5.1. Applying the indicators for visions by land consolidation

A screening of the future visions for the area selected around Glenstrup lake for sustainable land use by land consolidation was initially conducted for the five societal demands: *Farm Economy*, *Biodiversity Conversation, Outdoor Recreation, Environment* and *Rural Development*. The screening was carried out by applying each of the five indicators within each of the five Danish societal demands to explore what were the options for fulfilment of the demands. Below follows Boxes 1–5 illustrates one example from each of the five societal demands of applying the indicators.

At first glance, the project area seemed homogenous because of the lake and its central position in the area. However, when starting to use the indicators as screening tool it showed up that all five disciplines needed to differentiate their indicators. Both the landscape setting, farming structure and rural settlements were very different within the chosen pilot area. A subglacial valley, containing Glenstrup Lake to the west and wet meadows and the stream of Østerkær Bæk to the East, divides the area, and consequently three subareas was designated: The Northern, the South-Western and the Eastern part, see Fig. 5. This finding points out that even if project area for enhancing sustainable land use by land consolidation has been chosen because of a clear landscape characteristic the project should be open for that findings from applying indicators and consequently the visions for land

[1] A livestock unit is a reference unit, which facilitates the aggregation of livestock from various species and age via the use of specific coefficients established initially on the basis of the nutritional or feed requirement of each type of animal. (Source, Eurostat: https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary: Livestock_unit_(LSU)).

[2] The five societal demands were formulated within a Danish Collective Impact initiative "The countryside as a double resource" See more about the initiative and a full explanation of the Danish indicators and the methods used in Johansen et al., 2018a, 2018b.

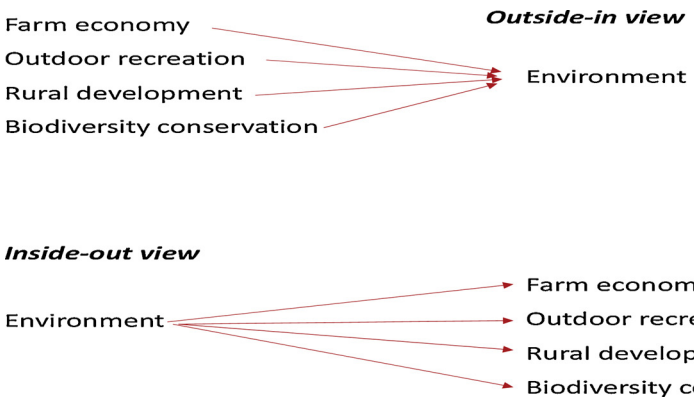

Fig. 2. Example of the two perspectives on the quantitative assessment of the positive and negative interactions assessed from the inside-out view – a specific indicator's impact on the other four societal demands – and the outside-in view – a specific societal demand's impact from the indicators of the other four societal demands.

Table 3
Average scores for positive and negative interactions.

	Inside-out view	Outside-in view
Environment	0.49	0.63
Farm economy	0.18	0.13
Outdoor recreation	0.03	0.75
Rural development	0.27	0.90
Biodiversity conservation	0.59	0.25

consolidation in the project area Glenstrup Lake. The visions for the five societal demands explained in the Boxes 6–10 :

The research-based visions for sustainable land use by a policy and planning project land consolidation at the Glenstrup Lake area illustrates that not all indicators can be involved in all settings.

5.2. Rating of positive and negative interactions between indicators in the project area

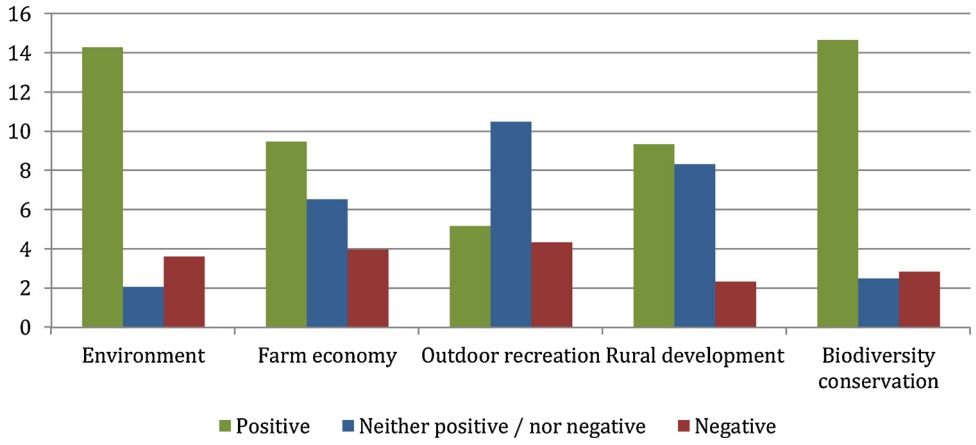

Fig. 3. Weighted number of synergy and conflict interactions from the inside-out perspective.

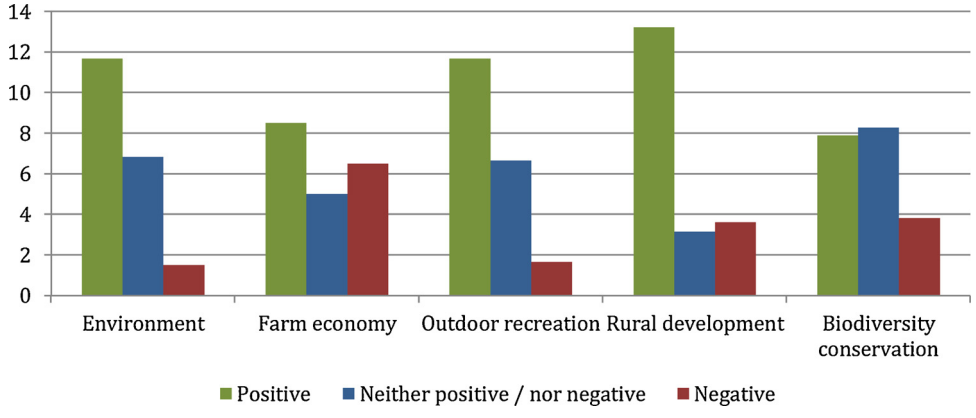

Fig. 4. Weighted number of synergy and conflict interactions from the outside-in view.

consolidation may turn up differently.

The procedure exemplified in the Boxes 1–5 was repeated for all the 25 indicators in all three sub-areas and thus forming the vision for fulfilment of the societal demands for sustainable land use by land

The visions developed for the three areas around Glenstrup Lake were anchored in analysis of the potential for the five societal demands for being realized. When clarifying the positive and negative interactions between the visions, the used. The total number of positive

Box 1
The Rural Development indicator 'house prices' refers to the attractiveness of an area for settlement.

That is if the house prices are very low compared to other rural settings in Denmark it is a signal of a non-attractive area, in which there is a risk that people living in the house are tying in either because they cannot afford to sell the house with an economic loss or because an interested buyer of the house will not be able to get the house financed due to the Danish banks and mortgage institutions loaning policy in rural settings with low house prices. When applying the indicator 'house prices' first a desk-research focusing on number of houses for sale, average square meter prices and average selling period in the project areas, the public and private service in and close to the project area and the infrastructure and public transport. Secondly a field study was carried out focusing on the general standard of the houses in the areas, the standard of outdoor maintenance, access to nature and landscape, the houses locations in the landscape and to the neighbouring houses and the type of farming and farming constructions for example standard, number and sizes of slurry tanks (Dubgaard, 2018). The data material from the desk research and the field study was then analysed and the findings were used for formulating the visions for the indicator 'house prices'.

Box 2
The biodiversity conservation indicator 'protection' refers to the degree to which areas have been effectively protected as habitats for wildlife (Jones et al., 2018).

Effective protection is provided through legal regulation, e.g. by the Danish Nature Protection act, Natura 2000 designation or area-wise declaration of nature conservation. Less effective are designation as forests, which protects against intensive farming but not against logging or intensive silviculture (Chaudhary et al., 2016). While approximately 9 % of Denmark enjoys a general protection against deliberate agricultural intensification, very few areas in Denmark are effectively protected against the main threats of drainage, logging, overgrazing and encroachment due to lack of natural disturbances – typically lack of natural grazers, but also lack of coastal erosion, sand drift, wildfires or wind throws (Svenning et al., 2016; Brunbjerg et al., 2015). The major source of information for estimating protection are the cadastral maps with information on the designation of land linked with a ranking of these designations according to the threat controlled by the due legislation.

Box 3
The Farm Economy indicator 'transport' refers to the transport of farm machinery, equipment, agricultural products, manure, and animals from farm to fields and in between fields.

Transportation is costly and non-productive, and a reduction in the distances would positively affect the farm productivity and income (Latruffe and Piet, 2014). Besides the distance between farm homestead and the fields as well as the distance between the fields are expected to influence the farm economic performance because of inter-field transportation of machinery such as plough and till-equipment. Finally, transportation of manure is from the location manure storage facilities, which implies transportation of manure to the fields where the manure is applied (Kaplan et al., 2004). The data used for calculating the transport distances is derived from publicly available data sources such as The Danish Agricultural Agency (information from applications for The Basic Payment Scheme). Secondly, distances from the landowner to fields were calculated to quantify the distance to the fields. Finally, the farms with large livestock production were analysed for identifying potential cost savings from reduced transportation of both machinery and manure if the land consolidation involved those farms. Those case-based and general quantitative assessments were used to formulate the visions for the indicator 'transportation'.

Box 4
The Environment indicator 'nitrogen emissions' refers to nitrogen forms – mainly as nitrate - being transported via soils to water from present and future agricultural land use.

Emissions of nitrate through leaching in the soil column on agricultural fields poses a risk for groundwater aquifers that is utilised for drinking water as well as for the ecological conditions of surface waters such as especially estuaries and coastal waters. The average annual nitrate leaching from all fields in the pilot area are calculated based on national databases where annual data is collected from farmers regarding crop types grown on their agricultural fields and data collected from the farms regarding fertilizer and manure utilisation. These data together with data on soil types and climate are input data to a nitrate leaching model that simulates annual nitrate leaching from each field (Kristensen et al., 2008). Combined with a national map of nitrate attenuation in groundwater and surface waters the risk for contamination of both groundwater and surface water with nitrate can thus be evaluated for all fields within the pilot area. This information, together with information from the EU Water Framework Directive River Basin Management Plans for the pilot area about nitrate vulnerable groundwater aquifers and surface waters is then used when setting up visions for the indicator 'nitrogen emissions' (Miljø- og Fødevareministeriet, 2016).

interactions between the five societal demands and the indicators are nearly equally high between the three sub-areas as they amount to 65 in the eastern sub-area, 60 in the northern sub-area and 64 in the south-western sub-area (Fig. 6). On contrary, the number of negative interactions differs between the three sub-areas amounting to 16 in the eastern sub-area, 8 in the northern sub-area and 12 in the south-western sub-area (Fig. 6). The relatively high number of negative interactions in the eastern sub-area is mainly driven by conflicts with *Farm Economy* being explained by the existence of three larger dairy farmers that needs their land for them to fulfil the obligations under the new national regulation limiting phosphorus inputs to land in catchments draining to ecologically sensitive lakes (Agricultural Agency, 2018). The findings of interactions between indicators also found that the number of positive interactions is highest for *Biodiversity Conservation* followed by *Environment* and *Outdoor Recreation* in the eastern sub-area (Fig. 6), whereas the ranking for positive interactions are *Biodiversity Conservation*, *Rural Development* and *Environment* in the northern sub-area (Fig. 6) and *Biodiversity Conservation*, *Rural Development* and Outdoor *Recreation* in the south-western sub-area (Fig. 6). *Outdoor Recreation* is the only societal demand having no negative interactions in our analysis of the Glenstrup lake area, followed by *Rural Development* (2), *Biodiversity Conservation* (3), *Environment* (9) and *Farm Economy*

Box 5
The outdoor recreation indicator ‘facilities/trails’ refers to the need for basic structures to cater recreational activities (Bell, 2007).

> Outdoor recreation facilities include a broad spectrum of features; a bench on a scenic location represents a modest alternation of the landscape while establishing a new campsite with parking lots demands both more space and resources. Trails are here understood as corridors for recreational transport like hiking, bicycling or horseback riding. The expert vision for improving the basic structures of facilities and trails in the Glenstrup Lake area is based on an analysis of the existing recreational infrastructure and the recreational potentials. First the existing structure was registered based on topographic maps, written sources (e.g. leaflets about hiking trails and web-based tourist and visitor information) and field visits to the area. Then potential recreational hotspots and missing links were identified. These were based on the same sources combined with research based knowledge about recreational patterns and demands, mainly referring to Danish investigations about outdoor recreation and peoples’ preferences such as (access to) water surfaces is valued very high (Jensen and Koch, 1997). Existing structures and recreational potentials were then compared and possible improvements for facilities/trails were identified. The accessibility of the locations as also possible synergy or conflict with existing opportunities was taken into account in the vision

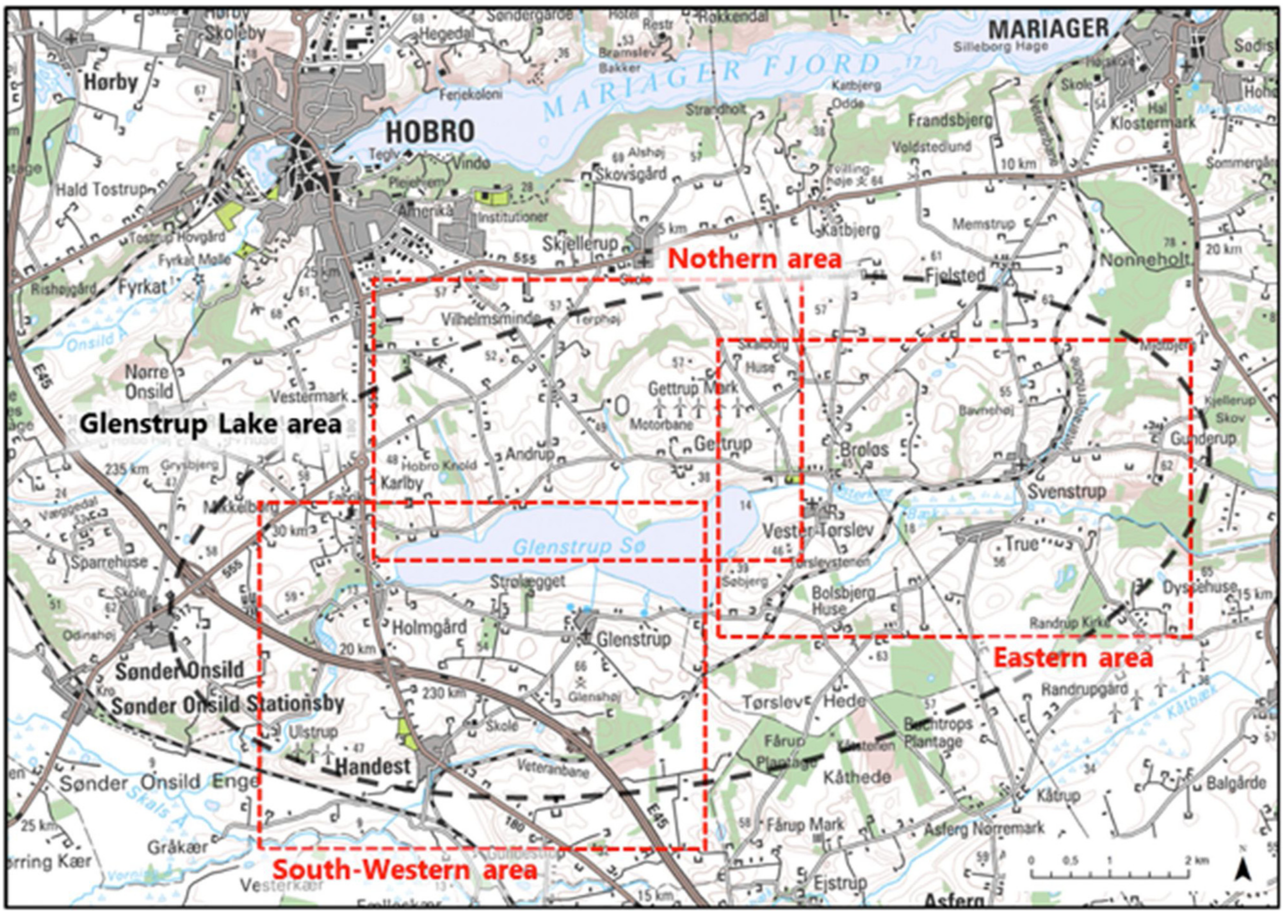

Fig. 5. The project area and the three sub-areas.

Box 6
Rural Development.

> Visions for the **northern area** are to introduce or develop local business that links to nature and/or recreational opportunities along the valleys by place branding products and services. Visions for the **southern area** are to create better links between the three existing rural settlements by creating a forested area that lowers noise from the highway and gives better recreational possibilities. There is an opportunity to take advantage of the easy access to the highway by creating an area for commuter settlements between two existing settlements targeting younger families with children. Another advantage that could be taking is to create tourism oriented outdoor events for example a climbing park, which could offer a brilliant view over the landscape. Visions for the **eastern part** are to establish and strengthen communities in the by establishing common grazed natural areas along the main tributary to the lake. New land for settlements could also be reserved at all four existing settlements with easy access to the existing and coming natural areas. The new settlements in this sub-area should be targeting families longing for self-production, close contact with nature and a quiet life.

Box 7
Biodiversity Conversation.

Visions for the **northern** part involve fragmented and overgrown natural grasslands, heath, meadows and bogs along two tributaries and some smaller spits that might be connected to larger grazed natural areas. Visions for the **southern** part involves converting existing, fragmented bogs, forest swamps and steeper slopes into a larger grazed natural area. Moreover, small springs along the slopes south of the lake could be included in a nature restorations project. Visions for the **eastern** part are high as a grazed nature area of national importance could be established along the corridor of the larger tributary to the Glenstrup lake linking to the nature areas towards the northeast and east.

Box 8
Farm Economy.

Potentials in the **northern** part involve to exchange sandy soils towards the western part of the lake and the border areas along the lake shore that are difficult to drain into more robust agricultural areas. Potentials in the **southern** part involve exchanging agricultural land within the lake catchment areas that are today having a phosphorus (P)-input limit with areas outside the lake catchment having no P-input limits. Moreover, to exchange the low-lying, organic rich soils along the lake shore with more easily drained areas away from the lake. **Eastern** part vision involves exchange of land having P-input limits with land outside the lake catchment. Generally, a better land allotment could be achieved in the entire pilot area around Glenstrup lake leading to lower transportation costs for farmers.

Box 9
Environment.

Visions for the **northern** area are to establish a 50 − 70 m wide uncultivated buffer zone along the lake and smaller stream restoration projects in the smaller tributaries for improvements of spawning conditions for lake trout and the general ecological conditions in streams and riparian areas. Visions for the **southern** part includes establishing a 50 − 70 m wide uncultivated buffer zone along the lake and to establish a natural hydrology by restoring smaller spring brooks and demolition of existing drainage ditches. Moreover, afforestation in parts of the high-lying agricultural areas would reduce nitrate leaching to groundwater and surface waters. Visions for the **eastern** area are to restore parts of the tributaries in this area by opening culverted reaches, re-meander channels and allowing natural trees to grow along the channels for reducing sediment and phosphorus inputs from bank erosion in the deeply incised channels. Moreover, the re-establishing of the drained lake (lake True) could be part of a major restoration project along the main tributary.

Box 10
Outdoor recreation.

Visions for the **northern** area are to establish recreational connections from the lake to the nearest town towards northwest along the lake or through the existing steep tributary valleys. Another issue is to establish a recreational hub at the lake shore which is today not accessible. Visions for the **southern** area are to establish recreational connections between two existing recreational hubs at the lakeshore and establish possibilities for recreational connections along the existing railway line that might open the landscape for residents and tourists. Visions for the **eastern** area are to establish tracks along the major valley system with trails, boardwalks, shelters and possible bird watching tower.

(20).

The findings from the analysis of interaction could also be presented on maps visualising the areas, which have many positive interactions and the areas, which may cause conflicts between societal demands.

Such presentation may be useful in debates with stakeholders. The Fig. 7 illustrate the maps that were used when presenting the research-based visions for the Glenstrup Lake areas and the interactions between them for the local community.

6. Discussion and conclusion

Since the adoption of Agenda2030 and the SDGs in 2015, policy-makers, interest groups, companies and individuals have tried to translate the coherent set of global goals into national or local context. The exploration of applying the SDG's to five Danish demands for sustainable land use adds to this effort by on the one hand illustrating how academia can contribute to localizing, contextualizing and operationalising the SDG framework and on the other hand demonstrating how Agenda2030 and the SDGs can be used as a tool for not only creating a new common communication platform, but rather creating an entire platform of operation. The platform allows academic disciplines to decrease complexity of the Agenda2030 by increasing own disciplinary complexity simultaneously with creating an integrated sustainability research approach. The nuanced way of approaching relations offers an opportunity to contextual employment of the seven-point scale at both minor and bigger geographical policy areas, as well as to concrete situations. The SDG framework offers an opportunity for creating an interdisciplinary operation platform. However, the study also found that it is imperial for the functioning of this platform to have a shared understanding among the involved researchers about how to deal with problem that academic disciplines – in Luhmann's (2000) terms – are autopoietic systems that by nature will seek to reproduce itself. Likewise, it was by recognizing the element of power - namely that dualistic knowledge regimes within the economic and bio-physics tend to leave behind the social demands for sustainable land use - that it was possible to approach the SDG framework as a framework for creating a common platform of operation. This leads to the suggestion that applying the SDG framework to nations and concrete situation call for engaging researchers across disciplines in discussions and debates with each other with an insight in the need for both decreasing outer complexity by increasing disciplinary complexity within disciplines and sectors and the power relations when creating a common platform of communication and operation.

The case illustrated that national societal demands of sustainable land use are comparable to a wide subset of the 17 SDGs and the underlying targets and the fact the both negative and positive interactions between goals are pertinent. Further, mapping the alignment between the five Danish societal demands for land use and the SDGs revealed a

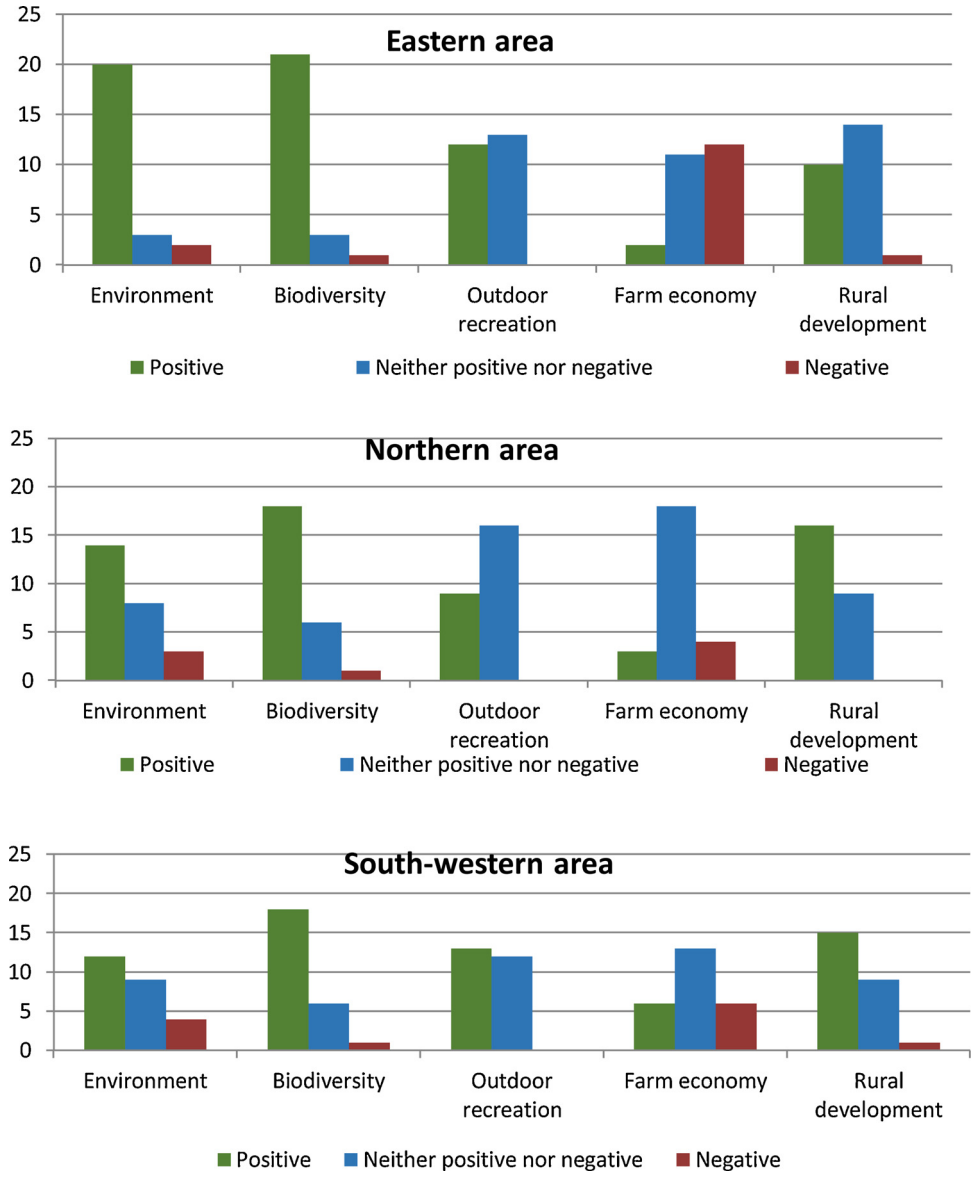

Fig. 6. Weighted number of positive and negative interactions from the outside-in view within each of three sub-areas to the Glenstrup lake case study area.

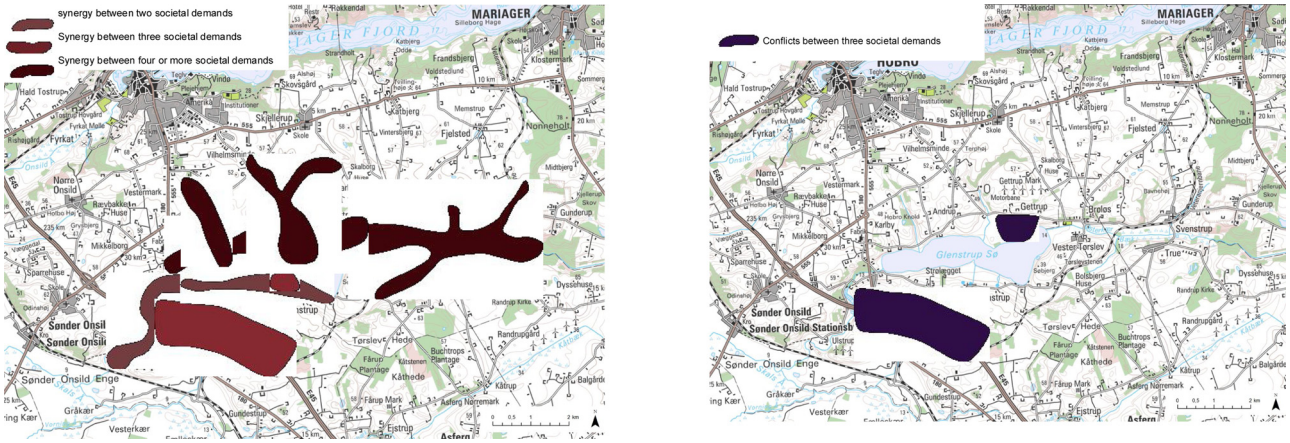

Fig. 7. Illustration of positive and negative interactions on maps.

novel consistency between the two as illustrated in Table 2. This consistency shows how reaching national societal demands for land use automatically contribute to achieving the global framework of the SDGs. The findings from developing and applying a localised SDG framework illustrates that Agenda2030 is applicable as an overall framework and tool for identifying and understanding the synergies and potential conflicts between societal demands for land use at a national and local level. The findings from the mapping of interactions between societal demands on a concrete case area revealed that some indicators and societal demands are more prone to conflicts than others but also on the local level there may be variations. Thus, a localised and contextualised SDG framework has shown useful insight for future projects on sustainable land use including land consolidation projects. This is essentially why an integrated sustainability approach inhibits great potential for achieving better use of land than a single or dual pillar approach to sustainable land use. In addition, by acknowledging the existing of negative interactions an opportunity is given to develop policy and planning instruments that can eliminate the negative interactions. The average values and the counts of scores suggest that some indicators and societal demands are more prone to conflicts than others, which is a useful insight for future policy and planning on projects on sustainable land use. In addition, by acknowledge that there are negative interactions an opportunity is given to develop policy and planning instruments that can eliminate the negative interactions.

Our case study disseminating positive and negative interactions between societal demands and indicators for land use to the citizens and stakeholders in the Glenstrup-study area reveals a number of potential challenges to achieve and pursue a research-based local agenda of multifunctional land use and spatial planning. Firstly, it may be discussed if the notion that merely presenting a cross-disciplinary synthesis of societal demands and indicators and their positive and negative interactions can by itself effectively bridge the gap between science and planning and science and citizens. Rather it may be expected that key stakeholders initially tend to respond strategically to presented knowledge, pointing to unresolved issues of power, privileges and incentives in the local community. While our cross disciplinary framework acknowledges and synthesizes negative interactions between societal demands, it does not replace the need for negotiation between authorities, stakeholders and landowners in order to complete the land-allocation process. Without such negotiation, the uncertainty concerning public support and investments, local opportunities, and environmental goals and regulation may lead to mistrust and conflicts as also identified by Benoit and Patsias (2017). Secondly, undeclared, yet unavoidable, societal demands and commitments derived from the regional, national or international level (e.g. Kallis and Butler, 2001) risk blurring the understanding of the democratic empowerment offered by the localised and contextualised SDG framework to the local citizens, eventually leading to frustration. Thus, it is not only among researchers representing different disciplines that there is a need for understanding the process of decreasing the complexity of the SDG framework by increasing complexity of own stakes and for facing the mechanisms of power that stand in the way for creating shared platform of communication among local stakeholders and among sectors in public administration. Creating landscape scenarios that include different local stakeholders' visions such as suggested by Gullino et al. (2018) may be a supplementing tool for forming a platform of communication locally and for decreasing complexity.

It should be stressed that stakeholder interests traditionally rely on and emerge from initially separate disciplines, social groups and administrative sectors (Rasmussen, 2014). It is thus a central challenge to allocate sufficient time to share experience and knowledge between disciplines and stakeholders. The cross-disciplinary integrated sustainability approach can be helpful in this process, but it needs to be accompanied by a deliberate cross-sectorial integration within the local authority, here the municipality, and amongst the groups of local stakeholders. It has taken years to accomplish such integration when developing the SDG framework and a similar timeframe is needed to allow for a comprehensive local integration process. It is our experience from presenting the visions and the interactions between them at meetings with citizens in the Danish case areas, that the dissemination of knowledge is stimulated by the involvement of scientists in the process. Such learning supports the findings by Arlettaz et al. (2010). It points however also to the need for educating and training for contextualising Agenda2030. The implications for academia include considerations about which disciplines to involve and on how to organize integrated sustainability research projects and publications.

While the article explored how to operationalise, localise and contextualise the SDG framework and Agenda2030 in the case of sustainable land use in Denmark, the knowledge and evidence-based analytical framework developed is not limited to the area of land use only but can be applied on other research, policy and planning areas. The contextual SDG framework developed draws on several of the tools that are embedded in Agenda2030, both by linking to specific targets – and not just goals – but also by exploring how to operationalise the four basic principles of the SDG framework: The principle of universality, the principle of leave-no-behind, the principle of sustainability and the principle of Policy Coherence for Development. The articles address the principle of universality by taking point of departure in a Danish case and by mapping alignment between Danish societal demands for land use with the SDG targets, hereby demonstrating the relevance of the SDG framework in a western industrialised and knowledge-based economy. Moreover, the case focus of land use and the research methodology of involvement of local citizens in the case areas is not only addressing SDG target 16.17 about ensuring responsive, inclusive, participatory and representative decision-making at all levels, but also the principle on leave-no-one-behind. Since the centralisation of institutions in urban settings people in rural areas are often left behind. Also, it can be argued that the case focus on sustainable land use as well as the cross-disciplinary research team contributing to an integrated sustainability approach is putting the principle of sustainability at the very heart of this article. Finally, the article operationalise the principle of Policy Coherence for Development by using a knowledge and evidence-based integrated approach to identify and understand negative (incoherent) and positive interactions between societal demands for land use and on the basis of this, developing a practical policy and planning instrument that can eliminate the negative interactions.

Author statement

We are very happy to re-submit our article' Exploring the interdisciplinary potential of the Agenda2030 - Interactions between five Danish societal demands for sustainable land use* to the Journal Land Use Policy. We confirm that the article has not been submitted to any other journals for publication.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.landusepol.2020.104501.

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