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Facilitating professional normative judgement through science-policy interfaces: the case of anthropogenic land subsidence in the Netherlands

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ABSTRACT
Science-policy interactions can both facilitate and hamper professional normative judgement, i.e. a value judgement about the desirability of a certain situation. Anthropogenic land subsidence, contributing to relative sea-level rise in the economically important Western peatland areas in the Netherlands is a case in point. The implementation of mitigation, adaptation and compensation measures is lagging, partly due to science-policy interaction problems potentially leading to conflicts between stakeholders, including agrarians, climate scientists and inhabitants. We find that professional normative judgement is enhanced when researchers and societal stakeholders reflect more critically on their role and engage in more inclusive science-policy interactions.

KEYWORDS
Normative judgement; sustainable land use; science-policy interfaces; wicked problems; the Netherlands; post-normal science

1. Introduction

Societal decision making related to the sustainable use of land requires normative judgement, which arguably incorporates the individual judgements of professionals, scientists, policymakers, societal stakeholders and citizens, involved in these decision-making processes. A normative judgment expresses a value judgement on whether a situation is desirable or not based on certain interests or principles. Such principles can refer to an ideal situation (e.g. sustainability), but also a desired course of a process (legitimacy and/or transparency) or a desired relationship between actors (equality and/or fairness).[1] This requirement has become both more urgent and more daunting over the years.[2] Science policy interactions are of large importance in facilitating normative judgement.[3] By closely involving scientists and scientific knowledge in the policymaking process, it

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[1]P.P.J. Driessen & H.F.M.W. van Rijswick, 'Normative aspects of climate adaptation policies' (2011) 2 *Climate Law* 4, 559.
[2]H.W.J. Rittel & M.M. Webber, 'Dilemmas in a general theory of planning' (1973) 4 *Policy Sciences* 2, 155; M. Hisschemöller & R. Hoppe, 'Coping with intractable controversies: The case for problem structuring in policy design and analysis' (1995) 8 *Knowledge and Policy* 4, 40; H. Bulkeley, 'Climate changed urban futures: environmental politics in the anthropocene city' (2021) 30 *Environmental Politics* 1-2, 266.
[3]S.O. Funtowicz & J.R. Ravetz, 'Science for the post-normal age' (1993) 25 *Futures* 7, 739.

can be elucidated which and whose values are served by specific courses of action. This is all the more important since, over the last two decades, this politicisation of sustainability problems has increased, as various stakeholders and governing actors have started to face the limitations of voluntary sustainability action.[4] The more pressing sustainability challenges become, the more vested interests start to become affected by policy responses directed at addressing them. In addition to that, science-policy interactions can help address the large uncertainties which many sustainability issues involve, including those related to climate-related drivers.[5] For instance, while there is scientific consensus that climate change will pose an unprecedented challenge for humanity, it is much less clear what we need to prepare for.[6] There are different scenarios for global warming, each with its own, uncertain, predictions of direct and cascading effects in terms of casualties, economic losses, and climate-induced migration.

As will be unpacked below, normative judgement regarding the sustainable use of scarce land is a wicked problem, with 'wickedness' being understood as each problem being considered complex and unique.[7] Under the heading of 'science-policy interfaces' (SPIs), various authors have proposed and empirically assessed processes, actors, mechanisms and organisations that may facilitate normative judgement in such value-laden settings.[8] SPIs have been defined as 'social processes which encompass relations between scientists and other actors in the policy process and which allow for exchanges, coevolution and joint construction of knowledge with the aim of enriching decision making'.[9] In the context of sustainable land use planning, SPIs shape and are being shaped by the values, actions and inactions of individual professionals: scientists, consultants, NGO officers, policymakers, societal stakeholders and citizens. Hence, sound professional ethical judgement is of profound importance for well-functioning SPIs. Vice versa, literature on SPIs can provide valuable lessons informing professional ethical judgement. Systematic empirical insights into the mechanisms through which and the conditions under which SPIs could enable normative judgement are still limited, though. This signals that there is a two-sided knowledge gap. On the one hand, the normative literature in the domain of environmental governance can be enriched by integrating insights from the literature on science-policy interactions. On the other hand, literature on science-policy interactions would benefit from more explicit attention to the different roles played by SPIs in enabling or possibly clouding normative judgement.

The current paper aims to address these knowledge gaps. We aim to provide empirical insights into how SPIs can facilitate normative judgement and therewith contribute to improved societal decision-making. We do so by analysing SPIs related to a specific and paradigmatic sustainable land-use issue, being land subsidence in the peatland areas in the Western part of the Netherlands. The current paper is to be seen as a

[4]Bulkeley (n 2).
[5]J.P. van der Sluijs, 'Uncertainty and dissent in climate risk assessment: A post-normal perspective' (2012) 7 *Nature and Culture* 2, 174.
[6]S. Dovers, 'How much adaptation: Are existing policies and institutions enough?' [2013] *Climate Adaptation Futures*, 95.
[7]Rittel & Webber's (n 2).
[8]W.I. van Enst, P.P.J. Driessen & H.A.C. Runhaar, 'Towards productive science-policy interfaces: A research agenda' (2014) 16 *Journal of Environmental Assessment Policy and Management* 1, 1450007; S. van den Hove, 'A rationale for science-policy interfaces' (2007) 39 *Futures* 7, 807; D. Hegger, M. Alexander, T. Raadgever, S. Priest & S. Bruzzone 'Shaping flood risk governance through science-policy interfaces: Insights from England, France and the Netherlands' [2020] *Environmental Science and Policy* 106, 157.
[9]Van den Hove (n 8) 807.

conceptual paper with an empirical illustration. Our aim, and the approach followed to reach it, will be further substantiated below.

Among the first authors to elucidate the importance of normative judgement regarding sustainable land use problems are Rittel and Webber, who coined the term 'wicked problems'.[10] The complexity and uniqueness of each wicked problem lies in the fact that it is historically and geographically situated; problems are interlinked and therewith each problem can be seen as a part or symptom of another problem. In addition, there are no definitive solutions to wicked problems. It is noted that various land use planning challenges, amongst which sustainability challenges, can be seen as wicked problems in that 'the political context is crucial, that argumentation must be transparent and robust, and that policy interventions may have consequences that cannot be easily controlled in open and highly pluralised social systems'.[11] At its core, the wicked character of land use planning lies in the fact that various societal stakeholders pose spatial claims on scarce land, spatial claims that both *accumulate* and *conflict*. Various societal functions require space, including urban development, mobility, agriculture, industry, amenities, nature conservation and development, and water storage. In some cases, societal functions can be combined and reconciled with environmental objectives, and there can even be win-win situations.[12] But the dominant thrust of current land-use patterns is one of increasing contestation and conflict. After all, what is under discussion is what the ideal future situation could be, how the process towards it should be organised, who should be involved and how the benefits and burdens of this transformation can be fairly shared. This is a highly value-laden debate.

Science-policy interactions can play an important role in this debate. Examples are boundary organisations, being organisations that operate on the intersection between science and policy,[13] processes of participatory knowledge production,[14] and boundary objects, products of scientific inquiry that have meaning both in the world of science and policy.[15] The question comes to the fore if, and under what circumstances, science-policy interfaces might contribute to 'sound' normative judgement in the context of land-use planning, and whether, how and to what extent they contribute to normative judgements as a follow up question. In the context of spatial planning processes, normative judgement should precede processes of societal decision making by explicating the values underlying decisions that both have long-term implications and need to be taken urgently, in the 'here and now'. Amongst other issues, normative judgement can pertain to the prioritisation of societal interests.[16] Which societal function is seen as key: climate mitigation, agriculture, housing, cultural heritage? Prioritising

[10]Rittel & Webber's (n 2).

[11]K. Crowley & B.W. Head, 'The enduring challenge of 'wicked problems': revisiting Rittel and Webber' (2017) 50 *Policy Sciences* 4, 539.

[12]E.g. nature-based solutions, see L. Xie & H. Bulkeley, 'Nature-based solutions for urban biodiversity governance' [2020] *Environmental Science and Policy* 110, 77.

[13]D.H. Guston, 'Boundary Organizations in Environmental Policy and Science: An Introduction' (2001) 26 *Science, Technology, & Human Values* 4, 399.

[14]E.g. D. Hegger, M. Lamers, A. van Zeijl-Rozema & C. Dieperink, 'Conceptualising joint knowledge production in regional climate change adaptation projects: success conditions and levers for action' [2012] *Environmental Science and Policy* 18, 52.

[15]T.F. Gieryn, 'Boundary-work and the demarcation of science from non-science: strains and interests in professional ideologies of scientists' (1983) 48 *American Sociological Review* 6, 781.

[16]E.g. Driessen & Van Rijswick (n 1).

certain functions inevitably leads to the down-prioritising of others, hence specific stakeholders will be faced with negative consequences. This points at the need to establish approaches and processes to promote distributional justice that recognise both the physically unequal allocation of environmental benefits and ills, and the uneven distribution of their associated responsibilities.[17]

Given positive experiences that have been documented regarding various SPIs, it is tempting to assume that such SPIs can contribute to better informed, and therewith better overall, normative judgement. But this assumption requires scrutiny, as SPIs are themselves part of the broader political context in which they emerge and function.[18] Findings in the domain of flood risk governance suggest that SPIs can be an important driver for desired change. But this change can be either transformative change or change along with existing – and potentially unsustainable – paths and trajectories.[19] Systematic empirical insights into the mechanisms through which and the conditions under which SPIs could enable normative judgement is still limited. This substantiates the above-mentioned knowledge gap and shows the potential to both enrich the normative literature in the domain of environmental governance and literature on science-policy interactions.

As written above, our contribution is a conceptual paper with an empirical illustration. Conceptually, the paper relies on the authors' combined expertise in land use planning and governance; normative judgement; science-policy interactions; as well as relevant physical processes related to land subsidence. We do not claim to be exhaustive in our treatment of relevant bodies of literature. Instead, the paper's novel contribution lies in the fact that it discusses links between these bodies of literature in ways that have not been pursued before.

Our empirical case study is the Western peatland areas in the Netherlands (Figure 1). These peatland areas are of high economic importance due to agricultural activities taking place there. Key stakeholders in the area are policymakers at municipalities and provinces, researchers, farmers and various (often nature-oriented) interest groups. At the same time, these peatlands are experiencing severe problems with subsidence because of peat oxidation and compaction due to the lowering of groundwater levels to enable agriculture. Subsidence has direct effects in terms of damage to buildings and infrastructure and leads to increased pluvial flood risks. Some science-policy interactions have been institutionalised to address problems related to subsidence which this paper will critically review. As regards the empirical case, no specific data have been collected solely for the current study. However, the authors relied on a wealth of existing data and insights, since land subsidence in the Dutch Western peatland areas has been documented extensively in the past decades.[20] In addition, the authors are currently

[17]G. Walker, 'Beyond distribution and proximity: exploring the multiple spatialities of environmental justice' (2009) 41 *Antipode* 4, 614.

[18]H.A.C. Runhaar, H.J. van der Windt & J.P.M. van Tatenhove, 'Productive science-policy interactions for sustainable coastal management: Conclusions from the Wadden Sea area' [2016] *Environmental Science and Policy* 55, 467; Hegger et al. (n 10).

[19]Hegger et al. (n 8).

[20]E.g. R.M. Den Uyl & M.J. Wassen, 'A Comparative Study of Strategies for Sustainable Development of Multifunctional Fen Landscapes: Signposts to Explore New Avenues' (2013) 21 *European Planning Studies* 6, 801.; H.A. van Hardeveld, P.P.J. Driessen, P.P. Schot & M.J. Wassen, 'An integrated modelling framework to assess long-term impacts of water management strategies steering soil subsidence in peatlands' [2017] *Environmental Impact Assessment Review* 66, 66; H.A. van Hardeveld, P.P.J. Driessen, H. de Jong, M. Nefs, P.P. Schot & M.J. Wassen, 'How valuing cultural ecosystem services can advance participatory resource management: The case of the Dutch peatlands' [2018a] *Ecosystem Services* 34, 113; H.A.

engaged in ongoing interdisciplinary research on land subsidence in the Netherlands which provides them with cutting edge knowledge on ongoing physical processes as well as a timely overview of stakeholder relations.[21] Methodologically, the selected case study has some characteristics of an 'extreme case' since, as subsequent sections show, accumulating and conflicting claims on scarce land, an important factor constituting the 'wickedness' of problems, can be said to be relatively large.

To achieve the research aim, the following steps will be taken. Section 2 introduces the problem of land subsidence in the Dutch peatland areas and embeds this problem description in a broader analysis of the science-policy interaction problems related to the issue and the need for normative judgement. Section 3 reviews SPIs that are currently in place in these peatland areas. The section provides an overview of types of SPI documented in the literature, assesses the extent to which these have been implemented in peatland areas and presents a first outline of these SPIs' outputs and outcomes. Based on this assessment, section 4 derives lessons and conclusions on the role played by SPIs in facilitating professional normative judgement, including implications for those professionals involved.

2. Analysing the problem of land subsidence in the western peatland areas: both a wicked and a science-policy interaction problem

2.1. Introduction of the case study

In the Dutch context, land subsidence is a pressing governance issue. Areas that are subsiding are areas reclaimed from the sea (polders), areas in the north of the country in which salt mining and gas extraction is taking place and peatland areas, approximately 223,000 ha in the Netherlands,[22] situated mostly in the western part of the country and to some extent in the north. Peatland areas contain soft soils and have to be drained continuously to enable societal functions such as housing and agriculture. But when drained, peat soils oxidise, mineralise, and compact, resulting in subsidence.[23] Compaction is to some extent reversible, but mineralisation is not. In addition, new peat, if at all, is formed at a very slow rate of about 1 mm/year.[24] On top of that, the expansion of built-up areas and infrastructural networks on soft soils constitutes an additional anthropogenic driver of land subsidence. Typical ranges for land subsidence rates in the Western peatlands are: on average 1 cm/yr up to a maximum of 2.5 cm/yr.[25] This is worrisome since ground levels in peatland

van Hardeveld, P.P.J. Driessen, P.P. Schot & M.J. Wassen, 'Supporting collaborative policy processes with a multi-criteria discussion of costs and benefits: The case of soil subsidence in Dutch peatlands' [2018b] *Land Use Policy* 77, 425; H.A. van Hardeveld, P.P.J. Driessen, P.P. Schot & M.J. Wassen, 'How interactive simulations can improve the support of environmental management – lessons from the Dutch peatlands' [2019] *Environmental Modelling and Software* 119, 135.

[21] E. Stouthamer, G. Erkens, K.M. Cohen, D. Hegger, P. Driessen, H.P. Weikard, M. Hefting, R.F. Hanssen, P. Fokker, J.J.H. van den Akker, F. Groothuijse & H.F.M.W. van Rijswick, 'Dutch National Scientific Research Program on Land Subsidence: Living on Soft Soils – Subsidence and Society' [2020] *Proceedings of the International Association of Hydrological Sciences* 382, 815.

[22] Den Uyl & Wassen (n 20).

[23] H. Joosten & D. Clarke, *Wise Use of Mires and Peatlands – Background and Principles Including a Framework for Decision-making* (Greifswald and Jyva¨skyla¨: International Mire Conservation Group and International Peat Society 2002).

[24] Den Uyl & Wassen (n 20).

[25] See also Stouthamer et al. (n 21); G.J. van den Born, F. Kragt, D. Henkens, B. Rijken, B. van Bemmel & S. van der Sluis, *Dalende bodems, Stijgende kosten* (Report The Netherlands Environmental Assessment Agency (PBL), report nr. 1064, 2016).

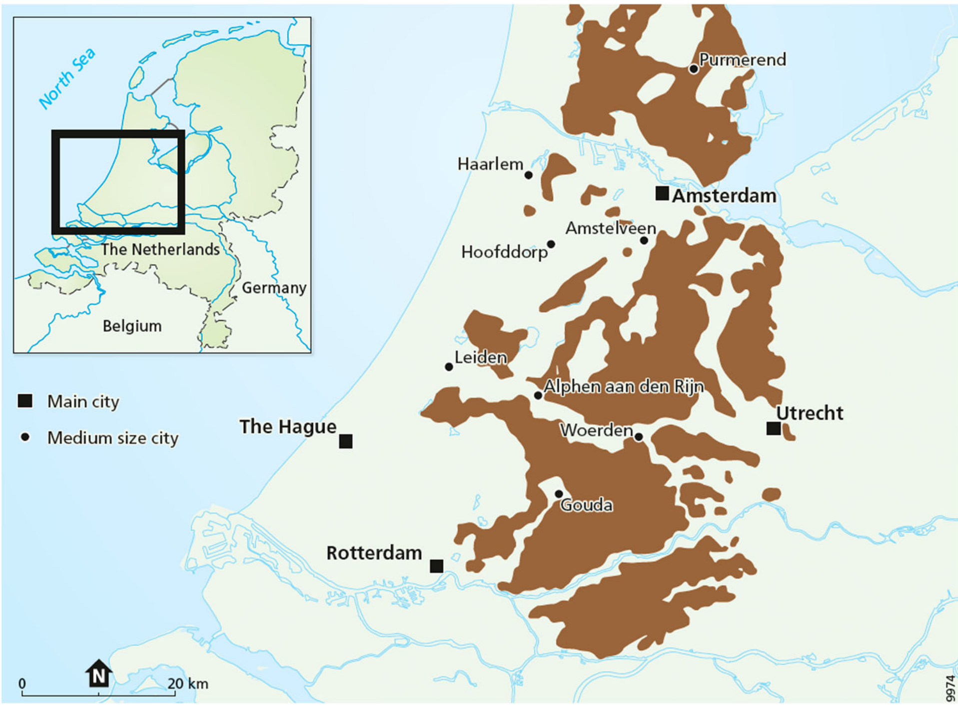

Figure 1. Peatland areas in the Western part of the Netherlands.

areas are already low and the effects of subsidence will be exacerbated by sea-level rise. At least in the short and medium-term (<50 years), the rate of subsidence outweighs sea level rise projections (being 2.4 mm/year),[26] and also in the long term (>50 years) land subsidence will continue to contribute to *relative* sea-level rise, being the combined effects of absolute sea-level rise and land subsidence. The subsidence *rate* of peatland areas is expected to increase further over the years.[27] Ongoing subsidence will lead to ecological deterioration, loss of nature reserve areas, loss of water safety, salinisation and damage to houses and foundations, amongst other damages. Damage costs related to land subsidence in a business as usual scenario have been estimated at 23 billion Euros until 2050.[28] Another consequence of subsidence is increasing flood risk. In addition to that, peat oxidation leads to greenhouse gas emissions and therewith contributes to climate change. The Dutch Climate Agreement of 2019 contains an emission reduction target for the peatland areas of 1 million tons per year by 2030.[29]

[26]F. Baart, G. Rongen, M. Hijma, H. Kooi, R. de Winter & R. Nicolai, *Zeespiegelmonitor 2018 – De stand van zaken rond de zeespiegelstijging langs de Nederlandse kust* (Deltares 2019).
[27]G. Erkens, J. Stafleu & J.J.H. van den Akker, *Bodemdalingvoorspellingskaarten van Nederland, versie 2017* (Deltares rapport klimaateffectatlas 2017); K. Koster, J. Stafleu, K.M. Cohen, E. Stouthamer, F.S. Busschers & H. Middelkoop, '3D distribution of organic matter in coastal-deltaic peat: implications for subsidence and CO2 emissions by human-induced peat oxidation' [2018] *Anthropocene* 22, 1.
[28]PBL The Netherlands Environmental Assessment Agency, *Dalende bodems, stijgende kosten* (2016).
[29]<https://www.klimaatakkoord.nl/binaries/klimaatakkoord/documenten/publicaties/2019/06/28/klimaatakkoord/klimaatakkoord.pdf accessed 8 November 2022.

2.2. Land subsidence as a wicked problem

To understand the nature and wickedness of land subsidence problems, at least three elements need to be considered. The first one is the historical and geographical context of the Western peatland areas. The human use of peatland areas has started centuries ago. Prominent economic activities were agriculture and peat excavation.[30] Agricultural activities have intensified over the years and therewith they have become of key economic importance for the region. As a result, various highly valued landscape characteristics can be observed, including the typically Dutch meadows with cows, windmills, lakes and canals which is considered cultural heritage.[31] Such historically grown patterns of land use cannot easily be reversed.

Second, the problem of land subsidence in peatland areas can be and is interpreted in different ways by different stakeholders, including policymakers at municipalities and provinces, researchers, farmers and various (often nature-oriented) interest groups, who hold different views on the feasibility and desirability of different management options.[32] While, on a general note, they seem to endorse more sustainable management of the Western peatland areas, they hold different views and have different policy priorities. In the first two decades of the twenty-first century, water management has been the focal point of the discussion. Different societal functions, and therewith different stakeholder groups, favour different groundwater levels. Farming practices generally require deep drainage (lowering the water table to 70–100 cm below the surface). Nature development and conservation, on the other hand, requires that groundwater tables are *raised* to conserve the peat substrate necessary to promote biodiversity.[33] Policy problems in the peat meadow areas have often manifested themselves as disputes over what would be appropriate water management options. Seen through the 'wicked problem' lens, viewing land subsidence as a *water management* problem is, however, only one of several potential problem definitions. Problems can also be understood as *economic problems* in that the physical constraints of peat meadow areas pose a risk to prominent and economically important agricultural practices and that houses in subsiding areas will suffer damage. Another interpretation is that problems are *land-use allocation problems*. There is a large need for new housing in the Western part of the Netherlands, which incentivizes urban development in low lying and subsiding polders. In addition, space is needed for nature conservation. Den Uyl and Wassen, writing about peatland areas in the Netherlands, UK and Germany, recommend that 20-30% of an area is used 'for rewetting and/or nature conservation' which could imply a reallocation of land use functions to plots.[34] The policy concept that land-use functions should follow water levels rather than the other way round (Functie volgt peil) has been explored and specified.[35] The issue of land subsidence and the discussion on mitigation strategies

[30]R. van Diggelen, B. Middleton, J. Bakker, A. Grootjans & M. Wassen, 'Fens and floodplains of the temperate zone: Present status, threats, conservation and restoration' (2016) 9 *Applied Vegetation Science* 2, 157.
[31]Den Uyl & Wassen (n 20).
[32]M.A. van den Ende, D.L.T. Hegger, H.L.P. Mees, & P.P.J. Driessen, 'Wicked problems and creeping crises: A framework for analyzing governance challenges to addressing environmental land-use problems' [2023] *Environmental Science and Policy* 141, 168; Van Hardeveld et al. (n 20); Den Uyl & Wassen (n 20).
[33]Den Uyl & Wassen (n 20).
[34]ibid. 801.
[35]D. Hegger, & C. Dieperink, 'Toward successful joint knowledge production for climate change adaptation: Lessons from six regional projects in the Netherlands' (2014) 19 *Ecology and Society* 2, 34.

can also be understood as a threat to highly valued *esthetic qualities of the landscape*.[36] Another potential interpretation of problems in peatland areas is that these are *drivers of anthropogenic climate change*. The reduction of GHG emissions was not seen to be a policy priority in the cases studied by Den Uyl and Wassen,[37] but the Dutch climate agreement has changed this situation, as mentioned earlier.

Third, and related to the previous two points, the context-specificity of the area combined with the plurality of ways in which the problem can be understood implies that there is no definitive solution to the problems. Elements of subsidence problems can be addressed, but the consequences of employed solutions are to some degree uncertain and may have distributive effects and therewith also produce new problems for specific stakeholder groups.

2.3 Land subsidence as a science-policy interaction problem

The scholarly literature on science-policy interactions (SPIs) seems to agree on the fact that the normative aim of SPIs is to 'enrich' decision making.[38] What 'enriched' would mean, and how it would differ from 'non-enriched decision making' is less clear.[39] A recurring argument, though, is that sound science-policy interactions should lead to knowledge that is seen as *credible* and *salient* and that is produced in a *legitimate* way.[40] Credibility refers to whether an actor perceives information as meeting standards of scientific plausibility and technical adequacy, and whether sources are trustworthy and/or believable. Salience refers to the relevance of the information for the decision-maker and the problem at stake. Legitimacy refers to the extent to which the produced knowledge has been respectful of the divergent values and beliefs of stakeholders, unbiased in its conduct and fair in its treatment of opposing views and interests. Arguably, normative judgement is facilitated in cases in which credibility, salience and legitimacy are high. But science-policy interaction *problems* will manifest themselves if one or more of the criteria of credibility, salience and legitimacy have not been met.[41] Van Enst et al. have grouped the potential causes of such a lack of credibility, salience and legitimacy into three distinct categories: strategic use of knowledge by policy; strategic production of knowledge by science; and operational misfit of demand for and supply of knowledge.[42]

The question comes to the fore, whether, to what extent and how these science-policy interaction problems are relevant for and manifest themselves in the Dutch Western peatland areas. When addressing Dutch peatlands more generally, Stouthamer et al. emphasised the presence of scientific uncertainty: 'the fact that there is still little understanding of the exact rates and processes causing subsidence. That makes that timeliness of implementing measures and their effectiveness are hard to assess by landowners and

[36]Den Uyl & Wassen (n 20).
[37]ibid. 827.
[38]Van den Hove (n 8).
[39]Van Enst et al. (n 8).
[40]D.W. Cash, W.C. Clark, F. Alcock, N.M. Dickson, N. Eckley, D.H. Guston, J. Jäger & R.B. Mitchell, 'Knowledge systems for sustainable development' (2003) 100 *Proceedings of the National Academy of Sciences of the United States of America* 14, 8086.
[41]Van Enst et al. (n 8).
[42]ibid.

responsible authorities, stalling implementation of measures at the large scale on which the problem is occurring'.[43] This diagnosis indicates that there is a lack of salience and, to a lesser extent, legitimacy. But different interpretations are possible of what causes this lack of salience and legitimacy. At least the following three can be distinguished.

A first, tempting, interpretation would be that scientific uncertainty is too large and should be reduced, for instance through more advanced and sophisticated land subsidence models, or through more comprehensive assessments of the pros and cons of various options for mitigating and adapting to land subsidence. Those modelling and measuring subsidence are confronted with the complexity of the area. There is large spatial variability due to the heterogeneity of the sub-surface and boundary conditions set by societal actors, that vary across space and over time, need to be taken into account. What makes this difficult is a lack of a generally agreed-upon method, the absence of sound measurements and questions related to the upscaling of such measurements. In Van Enst et al.'s terms, then, there can be said to be an operational misfit between science and policy due to differences in timeframes and levels of abstraction.[44]

A second slightly different interpretation would be that the disciplinary perspectives involved in addressing the problem provide incomplete coverage. For instance, knowledge about the behaviour of the physical system and the potential effectiveness of various management options needs to be complemented with those from other disciplines that can provide relevant insights on strategies and approaches for decision making in the face of uncertainty.[45] Stouthamer et al. refer in this respect to the relevance of governance, economics and legal studies.[46] While these have addressed land subsidence issues in peatland areas to some extent these disciplines have not yet been systematically included in integrated and holistic assessments of land subsidence problems and directions to take towards solutions.[47] Their inclusion will arguably involve challenges related to interdisciplinarity, including challenges of collaborating between natural and social sciences,[48] and between legal and social sciences.[49] This again points to a lack of salience in Cash et al.'s terms, but it is less clear what the root cause of this lack of salience might be.[50] This might also point at an operational misfit in that policymakers and societal stakeholders are insufficiently aware of the relevance, added value and complementarity of different disciplinary contributions and in a sense 'have insufficient access to knowledge'.[51] But also more strategic considerations might be at play in that science is used selectively or ignored deliberately. Some time had passed before the Dutch national government was willing to put those forms of land subsidence that are not caused by gas extraction on the political and research funding agenda,

[43]Stouthamer et al. (n 21) 2.
[44]Van Enst et al. (n 8).
[45]E.g. G.T. Raadgever, C. Dieperink, P.P.J. Driessen, A.A.H. Smit & H.F.M.W. van Rijswick, 'Uncertainty management strategies: Lessons from the regional implementation of the Water Framework Directive in the Netherlands' (2011) 14 *Environmental Science and Policy* 1, 64.
[46]Stouthamer et al. (n 21.
[47]E.g. Van Hardeveld et al., 2018b (n 20); Den Uyl & Wassen (n 20); Stouthamer et al. (n 21).
[48]J.H. Kwakkel, M. Haasnoot & W.E. Walker, 'Comparing Robust Decision-Making and Dynamic Adaptive Policy Pathways for model-based decision support under deep uncertainty' [2016] *Environmental Modelling and Software* 86, 168.
[49]I. Giesen, 'The Use and Incorporation of Extralegal Insights in Legal Reasoning' (2015) 1 *Utrecht Law Review*; S. Taekema & W. van der Burg (eds.), 'The Incorporation Problem in Interdisciplinary Legal Research' [2015] *Erasmus Law Review* special issues 2 and 3.
[50]Cash et al. (n 45).
[51]Van Enst et al. (n 8) 6.

possibly because of a misfit with other societal values at play. This changed to some extent when the Netherlands Environmental Assessment Agency (PBL) managed to quantify the potential economic damage.[52]

There is a third, possibly even more radical and provocative, interpretation of the nature of science-policy interaction problems in the Dutch peatland areas. This interpretation is that existing knowledge infrastructures and governance structures are closely intertwined to such an extent that both have become part of an underlying status quo. This status quo then would entail that knowledge is produced that aims to facilitate existing land use functions and therewith the vested interests of existing stakeholders, which might indicate a lack of legitimacy. The latter would complicate a critical and more fundamental reflection on the tenability of existing management practices, including the default practice that water levels are based on land use functions rather than the other way round. So-called 'weak interests' such as nature conservation and development would then have a more difficult time getting recognition due to their weaker position in the existing knowledge landscape *as part of* a weaker position in the overall societal playing field. Translated in Van Enst et al.'s terms, one could see forms of strategic production of knowledge in that knowledge is produced that is expected to be welcomed by policymakers; and strategic use of knowledge in that knowledge is used mainly to underpin, legitimize and therewith continue existing policies with only room for a minor change. In such a constellation, knowledge about win-win management options (e.g. underwater drainage) will be more welcome than knowledge about the (un)desirability of certain land use functions or the need for a reallocation thereof.

It is difficult to prove that knowledge is produced and used strategically and therewith detrimental to sound SPIs. Actors who willingly and knowingly behave strategically obviously do not have an interest in being too transparent about this. In addition, such strategic behaviour needs not always be a deliberate and conscious process let alone one inspired by 'bad intentions'. Science-policy interactions have developed over long periods and therewith their structure and mechanisms have become to some extent taken for granted, which might lead to different types of 'lock-ins', such as choosing for familiar but for from a long term perspective ineffective technical solutions. On the other hand, we can say that there is to some extent an incentive for actors to behave strategically. Others have documented the existence of so-called 'knowledge coalitions' in spatial governance processes.[53]

In conclusion, existing interactions between science and policy in the Western peatland areas can play out in different ways. They can help expand the solution space, which is always to some extent based on normative judgement but also contribute to maintaining the status quo. In short, there is the danger that policy debates focus on the interests of specific stakeholders rather than on an integrated assessment that combines all relevant interests. Therewith, contrary to what one might expect, science-policy interactions can complicate rather than facilitate and elucidate more fundamental debates about normative starting points of policies, including underlying justice principles, and the need for political choices these imply.

[52]Van den Born et al. (n 30).

[53]A. van Buuren & J. Edelenbos, 'Why is joint knowledge production such a problem?' (2004) 31 *Science and Public Policy* 4, 289; Hegger et al. (n 10).

3. Science-policy interfaces: typology and examples applied in the western peat land areas

3.1. A typology of SPIs

Inspired by Van Enst et al.'s work,[54] Hegger et al. distinguished between three broad-brushed categories of SPIs.[55] These are:

- **Institutions that act as interfaces**. Such institutions often have the shape of boundary organisations, that is organisations that have both scientific and policymaking tasks and place themselves at the boundary between the realms of science and policy,[56] or as knowledge brokers.[57] In terms of how boundary organisations are supposed to function, scholars studying them have often pointed at the importance of being accountable both to the worlds of science and policy.[58] There is a vast literature on boundary organisations,[59] however, the question of how they address normative issues has received comparatively limited attention. There are important open questions about how boundary organisations organise debates about the desired situation, whom they involve in that and how they deal with possibly unbalanced outcomes of such deliberations.
- **Interfacing processes and mechanisms.** A predominant focus has been on processes of participatory knowledge production through for instance joint knowledge production.[60] Joint knowledge production processes enable 'the exchange and negotiation of ideas, visions and knowledge'.[61] A key consideration in such processes of participatory knowledge production is that they might lead to knowledge of which it is unlikely that actors would have gained it in isolation and that might provide a starting point for more normative debate. Normative judgement then depends on who is invited to participate in knowledge production (and who not). Or said otherwise, 'sound' normative judgements are dependent on an inclusive representation of norms and values. Individual mediation between science and policy often forms an important component of processes of participatory knowledge production.[62]
- **Tools and resources.** Literature has pointed at a heterogeneous set of potentially relevant tools and resources. These include boundary objects,[63] that is material objects, but possibly also boundary concepts, to which different types of actors can relate. In the context of sustainable land use issues, serious games and interactive

[54]Van Enst et al. (n 8).
[55]Hegger et al. (n 8) 157.
[56]W.I. van Enst, H.A.C. Runhaar & P.P.J. Driessen, 'Boundary organisations and their strategies: Three cases in the Wadden Sea' [2016] *Environmental Science and Policy* 55, 416.
[57]W.I. van Enst, P.P.J. Driessen & H.A.C. Runhaar, 'Working at the boundary: An empirical study into the goals and strategies of knowledge brokers in the field of environmental governance in the Netherlands' (2017) 9 *Sustainability* (Switzerland) 11, 1962.
[58]Van Enst et al. (n 64); Guston (n 15).
[59]E.g. Van Enst et al. (n 64).
[60]Hegger et al. (n 8); Hegger & Dieperink (n 40); G.T. Raadgever, E. Mostert & N.C. van de Giesen, 'Learning from Collaborative Research in Water Management Practice' (2012) 26 *Water Resources Management*, 11, 3251.
[61]Hegger et al. (n 8) 157.
[62]Van Enst et al. (n 8); Hegger et al. (n 8).
[63]Gieryn (n 17).

maps are cases in point.[64] In addition to tools and resources that are deliberately designed as SPI, science-policy interfaces can be strengthened if, on a more general note, the necessary funding and support to invest in science-policy interactions are available.[65]

3.2. Analyzing SPIs in the western peatland areas

All types of SPIs distinguished in section 3.1 can to some extent be discerned in the Western peatland areas. Prominent organisations that have some characteristics of a boundary organisation include the TNO-Geological Survey of the Netherlands, Deltares and PBL the Netherlands Environmental Assessment Agency, as depicted in Table 1. However, especially TNO and Deltares work mostly for the national government and can, therefore, to some extent be seen as specific stakeholders with an interest in a specifically designed knowledge infrastructure. Interfacing between science and policy through dedicated processes and mechanisms also has a legacy that dates back to at least the beginning of the twenty-first century. In 2005 a prominent research programme 'Waarheen met het Veen' (What's the future of low-lying peat areas) started under the auspices of the Dutch National Research Programme 'Leven met Water'. It has been claimed that this project's set-up as an interactive joint knowledge production project gave an important impetus to innovative knowledge to address land subsidence in peatland areas.[66] This project provided insights into the potential of innovative applications of field drains as a means to reduce land subsidence.[67] Newer interfacing processes and mechanisms as depicted in Table 1 are arguably a follow up of these first initiatives to arrive at more holistic and integrated management.

Specific tools and resources for facilitating science-policy interactions in the Western peatland areas have been documented by Van Hardeveld et al.[68] Van Hardeveld et al. performed and evaluated Interactive Simulation Systems (ISSs) to facilitate stakeholder interactions.[69] The results of ten stakeholder workshops performed by them show the potential of such ISSs to apply more generic scientific research on a specific site from multiple stakeholder perspectives and by raising awareness of mutually beneficial strategies.[70] The authors showed that the ISSs provided actionable insights into the behaviour of the physical system, but also had the potential to stimulate deliberation on perspectives and values of different stakeholders. As the authors put it: 'Interventions that stimulate deliberation during the ISS workshops were shown to prevent individualistic strategies, and instead foster cooperative attitudes'.[71] Van Hardeveld et al. claim that two contextual conditions have contributed to the relative success of ISSs in expanding the solution space: i) through the involvement of specific persons, the ISSs were embedded in preceding Science-Policy Interfaces, including the 'Waarheen met het Veen' project. ii) the

[64]Van Hardeveld et al. 2019 (n 20).
[65]E.g. Hegger & Dieperink (n 40).
[66]R. van Brouwershaven & P.J. Lokker, 'Peatland, an authentic landscape' (2010) 27 *Landschap* 3, 121.; Hegger & Dieperink (n 35).
[67]Van Hardeveld et al. 2018b (n 20).
[68]Van Hardeveld et al. 2017, 2018a, 2018b & 2019 (n 20).
[69]Van Hardeveld et al. 2019 (n 20).
[70]ibid. 142.
[71]ibid. 135.

Table 1. Three types of science-policy interaction problems (based on Van Enst et al., 2014).

Science-policy interaction problem	Explanation	Likely outcomes
Strategic use of knowledge by policy	Oppositions and actors with conflicting interests or views using either existing knowledge or their knowledge and reports strategically, defending their interests, resulting in trade-off decision-making'[85]	Illegitimate knowledge production leading to a lack of credibility and possibly salience.
Strategic production of knowledge by science	Scientists (either individual or within coalition-type groups) appear to strategically place their interests and agenda within research, possibly leaving out other valuable information[86]	Lack of legitimacy and credibility
Operational misfit of demand for and supply of knowledge	'differences in culture, between the 'world of science' and the 'world of policy''.[87] Amongst other issues, this includes that scientists and policymakers employ different timeframes and levels of abstraction.	Lack of salience

participants had a certain willingness to reach a consensus on management strategies and develop win-win solutions.[72]

Van Hardeveld et al. assessed future management scenarios based on a multi-criteria discussion of costs and benefits together with stakeholders.[73] A key result was that 'the former top-down approach to raise water levels and achieve a transition in land use was not viable, because gains and losses were unequally distributed'.[74] This unequal distribution, however, did not lead to conflicts but instead inspired a discussion on how to jointly arrive at context-sensitive solutions. Specific features of the process, including the scientific soundness of the CBAs, their underpinning through modelling of natural system dynamics and the presence of ample opportunities to deliberate the results are claimed to have contributed to the relatively productive exchange of views between stakeholders. Similar findings were documented in Van Hardeveld et al., which also pointed at the generally high willingness and capability of stakeholders to deliberate, due to the presence of both suitable technical tools as well as participatory and deliberative processes of exchange of knowledge and viewpoints (Table 2).[75]

Van Hardeveld et al., report on the results of integrated modelling exercises in part of the Western peatland areas.[76] They have shown that this integrated modelling helps to quantify costs and benefits as well as their division over various stakeholders under various water management options. This modelling exercise was found to contribute to awareness-raising within the responsible regional water authority which, as a result of the findings, decided to focus more on the prevention of unequal land subsidence rates and large differences in surface elevation.

In all three examples listed above, SPIs facilitated an explicit discussion of values underlying specific courses of action, and therewith they facilitated normative judgement. At the same time, the SPIs helped reveal that, in the specific cases in which they were applied, different values were reconcilable. Distributive justice could be achieved by what some would call 'expanding the solution space'. The examples mentioned,

[72]ibid.
[73]Van Hardeveld et al. 2018b (n 20).
[74]ibid. 434.
[75]Van Hardeveld et al. 2018a (n 20).
[76]Van Hardeveld et al. 2017 (n 20).

Table 2. An initial overview of current science-policy interfaces (SPIs) in the Western peatland areas.

Type of SPI	Examples	Explanation
Institutions that act as interfaces	PBL the Netherlands Environmental Assessment Agency[88]	Broker between research institutes and the national government – mobilisation of policy-relevant knowledge about land subsidence
Interfacing processes and mechanisms	National Knowledge Programme on Subsidence (NKB)[89]	Users' platform of decentralised governmental actors, working on developing and connecting knowledge related to land subsidence.
	National Information Framework for Land Deformation (NIB)[90] (in development)	Primary information supply regarding land movement.
	National Knowledge and Innovation Programme Water and Climate (NKWK)[91]	National research programme with a research line on land subsidence
	Regiodeal Bodemdaling Groene Hart[92]	Alliance, funded by the national government, of decentralised governments, businesses, NGOs and research institutes focusing on addressing land subsidence in the Groene Hart region.
Tools and resources	Interactive Simulation Systems[93]	Series of ten workshops with in total 188 participants (stakeholders involved in Western peatland areas) engaged in an interactive simulation of social and ecological systems behaviour
	Discussing future management scenarios based on multi-criteria discussions of costs and benefits[94]	Collaborative assessment of division of costs and benefits over various stakeholders until 2100, based on four management scenarios that differ in the level of the surface water compared to the level of the soil surface
	Case study of participatory resource management through valuing cultural ecosystem services in Woerden[95]	Participatory workshops combined with a valuation of Cultural Ecosystem Services through various methods
	Integrated modelling of subsidence rates under different water management scenarios[96]	Assessment of subsidence rates and consequences for different stakeholder groups, including division of costs and benefits over these stakeholders

however, represented specific pilots which were not representative of all possible actors and factors in the Western peatland areas.

4. Discussion

4.1. Discussion of the findings: SPIs and normative judgement

We started this paper by stating that normative judgement, both concerning the prioritisation of societal interests and ensuring distributive justice, is necessary to facilitate long-term planning processes. The previous sections have shown that both political conflicts and the development of SPIs as a means to address them have a long legacy. Land use functions sometimes stand in conflict with each other, especially in those cases in which adjacent plots would require different water management strategies to sustain current land use functions. Incremental responses to such wicked problems, ones that maintain the status quo and do not explicitly address normative choices may culminate into what Boin et al. have coined a 'creeping crisis': 'a threat to widely shared societal values or life-sustaining systems that evolves over time and space, is foreshadowed by precursor events, subject to varying degrees of political and/or societal attention, and impartially or insufficiently addressed by authorities'.[77] A key feature of

[77]A. Boin, M. Ekengren & M. Rhinard, 'Hiding in Plain Sight: Conceptualizing the Creeping Crisis' (2020) 11 *Risk, Hazards and Crisis in Public Policy* 2, 116; van den Ende et al. (n 32).

a creeping crisis is that, due to the need for normative judgement, which politicians find unpleasant, symptoms may be ignored, downplayed or denied. We see two arguments to be positive about the potential of current SPIs to facilitate normative judgement and therewith address the creeping crisis as well as two limitations.

The first argument for optimism is that the SPIs as depicted in Table 1 have stimulated agenda setting and contributed to awareness-raising, not only regarding the problem but also regarding the normative dimension of potential solutions. In the past two decades, various SPIs at different levels, those of institutions, processes and tools, have been applied and partly institutionalised. Partly due to this, problems related to land subsidence, including its societal costs and benefits and divisions thereof over different stakeholders have now received attention from at least those decentralised governments and societal stakeholders that are most directly involved in the issue. As the preceding section has shown, science-policy interactions in the Western peatland areas are becoming more frequent and intensive. New networks and research projects are underway, including an interdisciplinary project funded by the Dutch National Science Agenda (NWA-LOSS) that explicitly incorporates the normative dimension.[78] This, combined with the fact that the national government has funded a 'Regiodeal' aimed at land subsidence signals that there is some political commitment to recognise and address the problem of land subsidence.

A second reason for optimism is that, as shown in the previous section, under certain conditions, boundary objects can facilitate stakeholder interactions, stimulate processes of joint fact-finding as well as deliberation, in a constructive atmosphere, of underlying interests and value systems. In so doing, they contribute to legitimate and transparent processes of debate and decision making and may therewith facilitate normative judgement. Hence, SPIs seem to have some potential to increase the solution space by facilitating explicit normative debate. The efforts to locally specify existing scientific insights about the behaviour of the natural system and the pros and cons of various management options are key mechanisms in this respect. In addition, moderation of debates focusing on dialogue instead of conflict, based on a jointly constructed knowledge base has contributed to credibility in terms of stakeholders' acceptance of scientific insights and legitimacy in that stakeholders had the opportunity to correct any biases in the knowledge production process.

But we can also give at least two limitations of the discussed SPIs for the facilitation of normative debate. First of all, the network of professionals working on the issue of land subsidence in the Western peatland areas is still relatively small. Those decentralised governments and societal stakeholders that are most closely involved are aware of the seriousness of subsidence problems, but these problems have not yet received the broad societal recognition that other prominent issues have. Once the societal consequences of subsidence become more clear to a broader audience, including the general public, a larger group of affected private actors and more politicians with larger visibility, a broadening and politicisation of debates on subsidence issues can logically be expected. One cannot take for granted that the terms of the debate will remain as largely constructive as they now often seem to be, but instead, debates might be (mis)used for political profiling rather than deliberation, complicating normative judgement.

[78]Stouthamer et al. (n 21).

Second, there will undoubtedly be limits to the potential of SPIs to increase the technical solution space, in which case normative judgement may need to imply trade-off decision making. The SPIs discussed in the current paper seem to be capable of facilitating and enriching decision making aimed at *incremental* policy and societal change. If, when and how these SPIs are also capable of facilitating more *transformative* change remains to be seen though. Examples of transformative change would be substantial shifts in the allocation of land use functions that favour the interests of certain stakeholder groups over those of others. One can expect that sooner or later, SPIs in the Western peatland areas will have to at least partly shift their emphasis from enhancing the solution space to providing input to conflict resolution and its associated normative judgement. Realising this shift in emphasis is a daunting task, as can be witnessed from shifts in discussions in adjacent policy domains.

4.2. Ways forward: bringing the normative dimensions into the knowledge production process

The previous steps in the argument show that, despite all its strengths, there is a need to further improve science-policy interactions in the Western peatland areas to facilitate normative judgement, that is a value judgement about the desirability of a certain situation by producing policy-relevant knowledge. To achieve this aim, science-policy interactions need to be made even more inclusive, incorporate more mechanisms for explicit discussion of normative considerations, while at the same time addressing the urgency of the issues at hand and incorporating the interests of future generations in the discussions.

These characteristics of the current state of affairs point towards the importance of what Funtowicz and Ravetz have termed post-normal science (PNS) in devising long-term planning approaches aimed at sustainable land use.[79] PNS refers, broadly speaking, to the engagement of extra-scientific actors and their bodies of legitimated facts and perceptions informed by diverse values and normative standpoints.[80] PNS scholars would argue that a broader extended peer community that ranges beyond the scientific realm should participate in knowledge production. This way, a broadening of the range of actors can lead to the inclusion of different types of knowledge, including practical or experiential, and different values and principles on which to base normative choices. Actors within such an extended peer community likely will not only bring additional knowledge but also gain important insights. They can learn about any biases present in their point of view and the overall complexity of a certain policy issue. As Skrimizea et al. emphasise, complex planning processes have an important ethical component, including determining the desired end-state of the natural system and discussing the implications thereof in terms of distributive justice.[81] Henceforth, the PNS perspective

[79]Funtowicz & Ravetz (n 3); as echoed by J. Corburn, 'Cities, climate change and urban heat island mitigation: Localising global environmental science' (2009) 46 *Urban Studies* 2, 413; Z. Kovacic, 'Investigating science for governance through the lenses of complexity' [2017] *Futures* 91, 80; R.A. Pielke Jr., 'Post-normal science in a German landscape' (2012) 7 *Nature and Culture* 2, 196; E. Skrimizea, H. Haniotou & C. Parra, 'On the 'complexity turn' in planning: An adaptive rationale to navigate spaces and times of uncertainty' (2019) 18 *Planning Theory* 1, 122.
[80]Funtowicz & Ravetz (n 3).
[81]Skrimizea et al. (n 96).

on inclusion of actors in knowledge production provides arguments for actor inclusion and participation additional to these actors being a stakeholder *sensu strictu*.[82]

More often complementing normal science approaches with PNS would imply that scientific approaches and results, including model predictions and the assumptions on which they rest, are more often opened to scrutiny. This could be an antidote to the models being met with scepticism, distrust or even outright rejection by policymakers.[83] As part of this endeavour, it might be necessary to give scholarship from social sciences, legal studies and humanities a more prominent place in the knowledge landscape, e.g. by more often incorporating expertise from fields such as legal studies, sociology, social psychology and philosophy. The fields of philosophy and legal studies provide themselves with normative frameworks. Social psychology and sociology, on the other hand, provide the analytical tools to empirically describe a normative reality.

4.3. Implications for professional ethical judgement

The landscape in which knowledge relevant for decision-making is produced and put to action is not abstract and impersonal. Instead, it is made up of professionals who are faced with the challenge of making sound ethical decisions. All of them will have to make their value judgements in terms of what a desirable situation would look like and, henceforth, decide how to address the normative and political dimensions of their work.

Scientists involved in processes of post-normal science are faced with the responsibility to be more mindful of the fact that their work is an inherent part of a societal decision-making process. They would need to reflect more on their own – actual and desired – role in this process. Pielke argues that researchers engaged in societal decision-making processes by definition have two options. They can either be 'honest brokers' who sketch various policy options and provide an as unbiased as possible assessment of the consequences, both positive and negative, of each option and, on the other hand, 'issue advocates' that provide arguments and evidence for a specific policy option and, possibly, favour a particular political position. Pielke argues that there is no a priori reason to see one role as more desirable than the other, but: (i) the two roles are mutually exclusive. Scientists cannot simultaneously increase the scope of choice (honest broker) and reduce it (issue advocate); (ii) it should be clear and transparent which of the two roles the scientist is playing. If a side produces and/or uses knowledge selectively while deliberately not being transparent about this, this is to be seen as 'stealth issue advocacy', something undesirable. (iii) issue advocacy can be functional, as long as all stakeholders have the potential to mobilise scientific expertise, to prevent the advocacy from being one-sided. Researchers being mindful of and explicit about the role they are playing requires that they are aware of ways in which their findings can be used strategically.[84]

But sound ethical judgement is equally important for all other actors engaged in societal decision-making processes related to sustainable land use, including

[82]As discussed by L. Davies & L. Henderson in this special issue.
[83]Pielke (n 96); A. Saltelli, G. Bammer, I. Bruno, E. Charters, M. Di Fiore, E. Didier, W. Nelson Espeland, J. Kay, S. Lo Piano, D. Mayo, R. Pielke Jr, T. Portaluri, T.M. Porter, A. Puy, I. Rafols, J.R. Ravetz, E. Reinert, D. Sarewitz, P.B. Stark, A. Stirling, J. van der Sluijs & P. Vineis,'Five ways to ensure that models serve society: a manifesto' (2020) 582 *Nature* 7813, 482.
[84]R.A. Pielke, *The honest broker: Making sense of science in policy and politics* (Cambridge University Press 2007).

policymakers, businesses and NGO officers. All of them will undoubtedly be faced with dilemmas, for instance, situations in which professionals' self-interest or the incentives they are faced with seem to conflict with reaching a certain desired situation. A well-known problem in the context of wicked sustainable land use issues is that formal and informal responsibilities of specific stakeholders are often fragmented, and sometimes their allocation is vague and ambiguous. This makes these responsibilities prone to political contestation. Our interactions with policymakers and consultants involved in the studied empirical case have revealed tensions between individuals' commitment to address sustainability problems holistically, and the more narrowly described role and responsibility allocation of the organisations they work for.

It is not a big leap to state that there is a need for higher education curricula to explicitly address the ethical dimensions of professionals' work. We see that curricula with a more inherent normative orientation, such as those in the sustainability domain, have made significant steps in explicitly addressing the normative and political dimensions of professional conduct. This is something that could be extended to curricula that used to be seen as more politically neutral (e.g. hydrology, legal studies).

5. Concluding remarks

Future-oriented decision making requires that science-policy interfaces provide not only technical or instrumental policy-relevant knowledge but at the same time facilitate normative judgement. The latter topic has been relatively underexposed in the existing literature. The current paper has engaged with this debate by studying a prominent case of a wicked sustainable land use issue: land subsidence in the Western peatland areas in the Netherlands. Such wicked problems run the risk of developing into creeping crises. The previous sections have shown that to better facilitate normative judgement, SPIs would need to move further on the path towards post-normal science and trans-disciplinary research. A dominant message that can be derived from the findings is the need to make science-policy interactions, including the scientific knowledge production process, more open and inclusive because that makes it possible to deal explicitly and transparently with normative judgements. Addressing this need, however, is easier said than done and has implications in terms of professional ethical judgement, being the value judgements of individual professionals. The previous sections have identified at least two key conditions to enable such ethical judgement: education has the potential to train professionals to make better personal judgements. But it is at least as important

[85] ibid. 5-6.
[86] ibid. 8.
[87] ibid. 9.
[88] <https://www.pbl.nl/en> accessed 8 November 2022.
[89] <http://www.kennisprogrammabodemdaling.nl/home/> accessed 8 November 2022.
[90] <http://www.bodembeweging.nl/> accessed 8 November 2022.
[91] <https://www.waterenklimaat.nl/onderzoekslijnen/nationaal-kennisprogramma-bodemdaling> accessed 8 November 2022.
[92] <https://www.rijksoverheid.nl/documenten/kamerstukken/2019/07/15/regio-deal-bodemdaling-groene-hart> accessed 8 November 2022.
[93] Van Hardeveld et al. 2019 (n 20).
[94] Van Hardeveld et al. 2018b (n 20).
[95] Van Hardeveld et al. 2018a (n 20).
[96] Van Hardeveld et al. 2017 (n 20).

that professionals dare to act upon these judgements, which might sometimes require them to 'go against the grain' and act contrary to the incentives they might be faced with. Claassen (this issue) even argues that professionals have a moral responsibility to do so. In any case, we must conclude that professionals, including scientists and other societal actors, involved in just sustainable land use planning are under more pressure than ever before.

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