

Referee comment on NHESS 2019 61: AGRIDE-c, a conceptual model for the estimation of flood damage to crops: development and implementation

The authors present a conceptual model for the assessment of flood damage to crops, offering a novel systematic and consistent approach that can be universally applied. They demonstrate the use of the model through a case application in the Po Valley, northern Italy, focusing on flood damage to the maize crop.

The paper is generally well written and argued. There is scope to improve the structure of the paper by separating the introduction of context and rationale, including statement of research objectives, and statement of methods to cover literature search, review of knowledge and construction of the analytical framework. There should be a critique of the approach. The case study then becomes results (reordering some results that currently occur in discussion). Discussion can then follow on both the case and the validity or otherwise of generic framework. Some items currently in the conclusion, particularly on gaps/further development, can go in discussion (they appear to be recommendations). Conclusion on what has gone before can focus whether the objectives (regarding the tool, its application and its prospects) have been met, rather than introducing new elements into discussion.

The work has merit in its approach and application. However, it probably would be best to be more cautious and modest about the claims made about the comprehensiveness and novelty of the approach, and its suitability to all circumstances and contexts. The grassland /livestock and flooding complex is not referred to, nor is land drainage (see below).

Further clarity on its potential application, either in cost benefit analysis of (publically funded) investments at the landscape scale in flood risk management, or in guiding individual farm-scale responses would be appropriate. The two applications are different in purpose and detail of approach. There is a difference between, for example, economic and financial appraisals. There is also a difference between ex ante appraisal and ex post evaluation, which is implied. This will support the important point made that insufficient ex post evaluation is undertaken to provide sound ex ante decisions.

One particular issue requires attention, namely the importance, especially in temperate climates, of agricultural land drainage. The control of water levels in the soil, and particularly the removal of excess water and below surface 'flooding' , including during the post flood phase before field return to 'normal' is an important aspect of agricultural flood risk management and assessment . Impacts and land management responses are often driven by seasonal waterlogging and drainage problems as much as they are by surface flooding. This is certainly the case in northern Europe and North America. There should be coverage of this aspect, and

the implications of not explicitly allowing for it in this model framework. Many areas of strategic importance are pump drained.

Water quality, notably associated with saline flooding, a major issue in coastal and tidal areas, should be referred to with implications for costs, especially regarding remediation and subsequent year impacts.

Surprising the authors do not mention climate change as a driver of concern or a factor affecting damage costs and responses. This seems an omission given the topic.

Further clarity is required regarding the definition of measurements of damage. A more detailed listing, upfront, of the revenue and cost related parameters would help: these emerge in the case application later on.

A table would be good to summarise the main elements of cost estimation processes /assumptions/ algorithms and where they come from. In the main, the methods draws on published data from Sub-sector models of crop damage or additional costs, such as Agenias et al. What other ones are used to transfers changes in yield, revenue and cost responses?

Further clarity would help regarding the use of the terms 'turnover' and 'gross profit', ie exactly what is in these terms? They are not universally applied in farm business accounting, where the terms gross output (or gross revenue), gross margin and net margin are often used. (Turnover can for example include sales from previous production periods – just to be clear). And the definition of gross profit may or may not include elements of farm level fixed costs, such as machinery and buildings costs (again to be clear, so that the methods can be generally applied). The use of 'relative' Gross profit measured at negative % values is difficult to interpret and doesn't mean a lot.

On flood scenarios, the treatment presumably here is for one-off relatively infrequent flooding on a land use that is not hitherto constrained by flood exposure. An increase in flood frequency, associated with climate change for example, or withdrawal of flood defences, could lead to increased flooding with a range of outcomes, permanent abandonment, repeat annual losses or a switch to more flood tolerant land use. How are these to be handled by the model?

The paper refers to spreadsheets and supplementary data containing both data and estimation methods. I had difficulty locating these and understanding them when I did. This is probably my fault. It would however be good to explain what is in them and how they can be reliably accessed.

There is a need to strengthen the treatment of inherent variation and uncertainty in the estimates. Most are given as single values. There is some passing reference to variation in yields in the case. How is variation modelled and reported?

Linked to the last point, there is a need to provide a more systematic critique of the model and the resultant damage estimates, and implications for use and improvements . At the moment this is mainly confined to the last paragraph on page 19.

The authors report that their work draws on systematic review of multiple sources, including expert judgement. This aspect, especially the latter, is under reported. Did the research approach follow a particular methodology that can be supported by literature, especially engaging experts?

I think the paper can make a useful contribution and the authors should be encouraged to further develop the paper in the light of review and discussion, especially regarding the following .:

- Some reordering of contents

- Greater clarity on context and purpose of the model,

- Some extensions to the literature reviewed

- Explicit reference to agricultural land drainage as its association with flood risk management (where drainage addresses below surface flooding),

- Critical review of the approach and its advantages and limitations as the basis for improving decision support in this important area (and hence holding back on some of the claims made)

Abstract

I think the abstract would better begin with a statement of context and purpose, and how the proposed model seeks to make a contribution to decision support. I think it best to avoid giving the paper an identity by using 'this paper....' as a writing style here and in the manuscript itself ; it is the authors who are reporting their work. As above, I think some cautious modesty would be advisable. CBA implies welfare assessment. Farmer decision support is something else.

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Page/line	Comment
1/20	What are flood risk management plans, and what is the implication of CBA ?. This implies public investment at the landscape scale, often funded through the public purse, as implied by CBA
1/23	I would avoid, 'in this paper', here and elsewhere
1/25	<p>River restoration usually implies rejoining the river to its floodplain and set back of (previously installed) flood defences in the conventional sense.</p> <p>see</p> <p>Morris J, Bailey AP, Lawson CS, Leeds-Harrison PB, Alsop D, Vivash R (2008) The economic dimensions of integrating flood management and agri-environment through washland creation: A case study from Somerset, England. J Environ Manage 88:372-381</p> <p>Rouquette JR, Posthumus H, Morris J, Hess TM, Dawson, QL, Gowing DJG (2011) Synergies and trade-offs in the management of lowland rural floodplains: an ecosystem services approach. Hydrol Sci J 56(8):1566-1581</p> <p>Is the context to justify of guide decisions in flood risk management infrastructure and operations made at the landscape/sub catchment/shoreline scale , with support from the public purse. This is the case in many parts of northern Europe and north America. Getting a handle on damage costs to agriculture is part of this ?</p>
1/29	<p>I think this is partly reflecting a limitation of the use of selected key literature search terms and also confinement to formal academic, rather than grey literature and institution-based activities and outputs.</p> <p>There is a history here in this topic : Since the 1930s, and probably up to the mid1980s, the focus in this area in northern Europe was on 'land drainage' of which flood protection , (rather than 'flood risk management'), was a part. Major investments, including large scale pumping schemes, were made to control /remove excess soil water and simultaneously alleviate surface flood from river, tidal and shore line sources. Many of these investments were 'land reclamation (for agric) projects' often involving major river works (and not river restoration) . Thus land drainage and flood control were and are inextricably integrated (just as irrigation and drainage are). The authors should in my view show an understanding of this nexus, and consider how, without undermining what they have done, it can be incorporated here.</p> <p>Including the terms agricultural/land drainage in the search would go some way towards this, as would 'flood risk '. Much of the work was carried out by research</p>

	<p>institutions as part of national programmes and is reported in sources that are not as easy to access.</p> <p>A bit dated , but see for example, Morris, J. 1992.</p> <p>Agricultural land drainage, land use change and economic performance: Experience in the UK. <u>Land Use Policy</u> <u>Volume 9, Issue 3</u>, July 1992, Pages 185-198</p> <p>And for decision support :</p> <p>See Chapter 9 Flood Risk Management for Agriculture, in:</p> <ul style="list-style-type: none"> • Penning-Rowsell, E., Priest, S., Parker, D., Morris, J., Tunstall, S., Viavattene, C., Chatterton, J. and Owen D. (2013) Flood and Coastal Erosion Risk Management: A Manual for Economic Appraisal, Routledge, Abingdon, Oxford
2/5	<p>I think also there has been a policy shift, especially in Europe post 1980s when agricultural surpluses increased under EU CAP and the subsidies to agric were being challenged , and urban flood damage increased in absolute as well as relative importance.</p> <p>Also the drainage link is important here : the emphasis in Europe and N America was on drainage land and reclamation.</p>
2/13-14	Suggest avoid etc , and ‘this paper’
2/15	<p>Some of the comments here seem premature: we haven’t yet explained the approach and the model, but seem to be drawing conclusions , unless these are objectives . The authors might want to consider a clear statement of the objectives of the work reported here, and then subsequently review the extent to which they have been able to meet them .</p>
2/25	<p>Should table 1 be part of methods ?</p> <p>What of ‘flood risk’ and ‘drainage’ as key search terms ?</p> <p>And using experts to identify sources ?</p>
3/ 3	<p>Would be good to clarify the perspective and purpose of the assessment of damage costs: ex ante or ex post, and the implications : the term ex post is used later without explanation.</p>
3/10	<p>Agree there is paucity of data on actual flood impact costs , recorded during and post flood. This observation is not confined to the agricultural sector (Chatterton et al, for the English cases for example, including agricultural damage).</p> <ul style="list-style-type: none"> • Chatterton, J; Clarke, C; Daly, E; Dawks, S; Elding, C; Fenn, T; Hick, E; Miller,

	<p>J; Morris, J; Ogunyoye, F; Salado R. .2016. The costs and impacts of the winter 2013 to 2014 floods. Report SC140025/R1. Environment Agency, Bristol. http://rpaltd.co.uk/uploads/report_files/the-costs-and-impacts-of-the-winter-2013-to-2014-floods-report.pdf</p> <p>There is a large, albeit now dated literature on drainage /water logging impacts on agricultural production that should be referred to, with modelling of the link between soil- water, crop growth and yields, and particularly linked to water level management in the context of land drainage and associated flood control measures.</p>
3/10	<p>See Chapter 9, section 9.5, p336 in Penning-Rowssel, opcit For FLOOD_{FARM}, that assesses the cost of flooding at the farm scale</p> <p>Where FLOOD_{FARM} = (costs associated with flood impacts on) ARABLE+ +GRASS+LIVESTOCK+OTHER.</p> <p>See also</p> <p>Dunderdale J A L and Morris J. 1997. The Benefit: Cost Analysis of River Maintenance. Water and Environment Journal. Volume11, Issue 6</p> <p>Pages 423-430 https://doi.org/10.1111/j.1747-6593.1997.tb01375.x</p>
3/25	<p>I am not sure the assumption of full loss is true here.</p> <p>The Posthumus, and the Morris and Brewin examples, based on farmers reported assessment of damages, incorporated ‘partial’ losses, and also losses in the following years.</p> <p>And also on farms adapting to flood risk: Pivot J.M., Josien E. & Martin P. Farms adaptation to changes in flood risk: a management approach. J Hydrol 2002, 267, 12–25.</p> <p>The ex-ante estimation methods described in Penning Rowsel above, for use in the appraisal of flood investments for agriculture, explicitly build in allowance for seasonal variation in yield loss between different crops (including grass) and livestock.</p>

3/29	<p>Should define Gross profit as gross output minus direct costs. The term Gross Margin is widely used in agricultural /farm business accounting circles.</p> <p>(there is an interesting accounting challenge here : what is considered a direct, avoidable cost in the context of flood impacts, especially when lots of field operations are carried out by contractors)</p>
6/1	The agricultural flood damage estimation
6/7	Is this a tautology ?
6/7	Should this be 'and/or': with respect to data source, estimation and valuation methods: eg some models have both physical quantities and unit monetary values.
6/10	<p>Implies that this would be good idea?</p> <p>Again need to set in context of the purpose of the 'modelling', high level or detailed assessment ? A number of Environmental bodies use very high level 'cost calculators' to derive quick assessments of flood impacts at the large scale , eg using 'standardised' damage costs \$/ha, for example to respond to immediate questions by politicians post flood .</p> <p>There is guidance on this > The UK Environment Agency use a Flood Cost Calculator , European Commission are promoting a standard approach to disaster observation , see for example http://publications.jrc.ec.europa.eu/repository/bitstream/JRC110489/loss-database-architecture-jrc110489.pdf</p>
6/7	well reproduce increasing costs?
6/12	<p>Says Agenais model is physically, presumably yield based , but then says it uses gross profit (gross output (turnover) less direct costs : isn't this monetary (cost) based .</p> <p>Some further clarity of the distinction between physical and monetary estimation would be useful with definition of terms used</p>
	They both imply that duration is probably more important than depth ?
7/20	Some more detail on the methods used to define the boundary of investigation , and the methods used to elicit important parameters and values from experts and other sources. Was a formal research method used? Was the research review for example formally a 'systematic' review, and were the experts 'systematically' engaged? Would be good explain how the research topic was framed and bounded , and the issues arising. What is the implication of an expert based approach here? This is an important methodological aspect, and liable to bias that needs to be managed ?

7/30	How is turnover defined . For the purpose here is it Gross Output (Q x P) specifically for the damage to crop outputs in a given period. Turnover in an accounting sense can be something else. Need to explain.
	<p>Need to be explicit on definition of production costs here. Presumably the concern with a costs across the farm business (non revenue items), including replacement and remedial costs, net of savings in uncommitted costs Gross profit is usually after direct costs (or the cost of good sold) , but much depends on how overheads/fixed costs are categorized .</p> <p>How are changes in machinery operating costs , or ‘other’ damage costs to machinery, buildings and infrastructure being assessed, or are they not included here , given the implied focus on ‘field’ scale costs?</p> <p>I think a table to support equation 1 should show the revenue and cost items that are used in the assessment : what is in and what is not ? Lots of jobs are done by contractors : how are these valued ? what of within season reseeded costs, reduction in gross output or profit associated with crop substitution , clean up and remedial works, following year impacts? A list would be good . I see these come later for the Po example, but a classification for the model would be useful; Elements are suggested in figure 1 , but it is not clear which are explicitly measured revenue and cost items</p>
8/figure	<p>Useful diagram. Where would salinity fit, and field flooding/waterlogging as it affects field access and timing of operations both within and beyond the immediate flood period ?</p> <p>Not all elements are ‘valued’ in the model</p> <p>Pri’c’es.</p>
8	Does the model include grassland and associated grassland management and livestock systems? If so, how are flood impacts assessed?
9	<p>A summary of estimation parameters and algorithms would be helpful, possibly linked to the table of estimation items referred to earlier, summarizing the estimation basis . Presumably these are listing in the supporting spreadsheets: I tried but had difficulty accessing</p> <p>See my comment on the Po case later : the approach is one of ‘estimation transfer’ . And there are some implicit criteria for transfer that could be made more explicit</p> <p>It would be good to say what is not in there : are damage costs to farm infrastructure, crops in store, included ?</p>

10/10	Are there thresholds for assumptions on crop switching/reseeding ?
10/25	So the scenario is for a single freshwater flood occurring in a given production year ?
11/5	Implications of grassland?
11/10	What year price base is used ? Were annual price series inflation adjusted to a common year ? similarly with costs?
	<p>'annual EU contributions for agriculture as a further income for the farmer and, in detail, the subsidies given to agricultural activities in...'</p> <p>Not clear how these are being treated. Presumably farmers get decoupled income support at the farm scale under CAP and these are unaffected by the flood, so can be left out for a single flood event. What of production subsidies: will not these also continue for the year of the flood, so from a farmers viewpoint costs (and cost savings) are net of subsidies?</p>
	consultation of regional price books: reference?
11	<p>Is the assumption that all the costs shown in Fig 3 are direct costs (and therefore included in Gross profit as defined here) and are potentially 'avoidable' . This might be the case if farmers are using contractors , but if they are using own equipment and labour, how much of these are avoidable costs. Some explanation of the treatment of field operations and related costs would be useful. Some costs are more direct than others. The reference to fixed costs on the next page suggests that most costs are regarded as direct. The estimates are very sensitive to assumptions about the treatment and behaviour of costs : a tricky subject.</p> <p>I don't quite follow: I got E927 using the numbers presented , but there may be other costs not shown.</p> <p>Even so, the gross profit as defined for maize seems high > maize farmers in the Po Valley are doing well.</p>
12/10	This approach should be more fully explained in describing the model above , that algorithms are judiciously 'transferred' from research applications elsewhere according to suitability/relevance, and availability
12/16	Delete first 'nor'
12/25	According to regional price books, restoration costs have been estimated to be equal to 500 €/ha (see Table 3). Would be good to reference these sources: Were contractors contacted? These seem very high unit costs . As for that matter do field operating costs , eg Harvesting at almost E800 /ha?
12/25	So the damage to soil box in Figure is aspirational?
14/10	I am surprised that a yield (and possibly price) penalty is not included in the assessment of reseeded crops, given the importance of timing of

	<p>operations. There are generic yield functions available for timeliness that would support a relative estimate of yield and gross output loss. This is one topic where local experts and farmers would have an empirically based view .</p> <p>The comment about variation and uncertainty in the estimates is valid for the modelling as a whole, and should be made as part of the method critique</p>
14/15	yes
14/16	Break stage? There is no crop in the field? Presumably also depends on crop rotation .
15/22	In my view gross output or gross revenue would be a better term than turnover, throughout . (Turnover refers to total sales in a period, sales may include items from other production periods)
15/24	Seems unlikely that there would be no yield penalty for delayed planting. Furthermore, reseeding would probably not be feasible immediately post flood because of field conditions . Penalty delay functions could be used .
15/30	Finally?
16/figure	<p>Would be good to make the axes consistent amongst the graphs , and for cost and turnover estimates.</p> <p>Would also be good to indicate net margin (or gross profit) , although this might complicate the graph. If a read it correctly, for a june flood, reseeding will not make sense , especially if there is (likely) yield penalty: I note for this graph the two 'y' scales are common</p>
17/9	This raises the question about likely average annual damaged according to the likelihood of a flood occurring within given months : where information is available on annul flood probability, and seasonal distribution, and to complicate further, whether seasonal distributions vary according the severity of the flood ? I see this is raised later
18/figure 6	Is this really a table. The title does not explain that it is relative gross profit : this is difficult to interpret when the preceding assessment was made with respect to turnover ad costs, so some clear explanation is required. Is a relative loss of gross profit greater than 100% a helpful measure?
18/15	The use of the term CBA needs explanation: it implies public choice and assessment of welfare change associated with public investments .
18/16	Quite consolidated practices. Meaning?
	limited to the direct avoided damage to people and some exposed items . this is not clear
	18/19, Conversely? See Penning Rowsel et al for Guidance, and for the UK approach
18/24	The points here are not clear. I suggest the whole paragraph might be recrafted

	to advantage, with some examples to support the argument
18/26 and para	I am not convinced Figure 6 does this. What does the greater than 100% refer to: is this the gross profit estimate in Figure 6. Assumption of no yield loss with (delayed) reseeding probably underestimates losses . There may be opportunities for reseeding with a different crop, especially between winter sown and spring sown crops
17/30	Apart from EU contributions? Not clear
17/30	Sustained? Already committed/incurred
19/0-10	These are valid and critical points., and fundamentally concern the underlying variation and uncertainty in the estimates (that have been single values so far). In my view it would be more appropriate to include the treatment of variation and uncertainty in the description of methods and the presentation of results of the case, rather than raise it for the first time here in discussion, where the purpose is to critical discuss the methods and results.
19/figure 7	This is results and should go there above. The figure is presumably for the Po case? The likely effect of a 10% penalty that would most likely arise due to (delayed) planting is apparent : negative gross profit. A figure showing absolute changes in gross profit (as defined here) might be useful in the results section.
19/16	Rather than saying 'must' it would be better to say why, identifying the advantage of doing so
19/17	Perhaps rather than 'no more' , 'not only.... but also' seasonal probabilities Is the Morris and Hess ref 1988?
20/0	This paper? The reference to the spreadsheet and to supplementary data needs further support : these are mentioned in passing
20/5	It depends how far the Authors have looked, and with the information presented here it is difficult to judge whether they can substantiate the claim. It might be fair to say they see advantage in developing a generic framework that can potentially be applied across different geographical and economic contexts , and they have made progress in this respect. For example, in more temperate part of Europe, land drainage is a particularly critical component of the land use: flooding nexus, and is particularly critical during post flood periods .
20/16	It would be useful to have a description of the sub models used , as referred to earlier . A summary table showing the estimation methods and sources would be

	particularly helpful , linked to supplementary data.
20/20	Damage mechanisms- Meaning ? Drainage and soils might be important also. And also salinity issues in coastal areas, as referred earlier .