BRIDGING THE KNOWLEDGE GAP TO BOOST SME FLOOD RESILIENCE

FINAL REPORT

About

This project was led by Dr Paola Sakai, from the University of Leeds supported by UKRI Economic and Social Research Council (ES/S001727/1), in partnership with Dr Marco Sakai from the University of York, the Yorkshire Integrated Catchment Solutions Programme was the main financing partner of this initiative (with UKRI Natural Environment Research Council grant), with further funding from the West Yorkshire Combined Authority and the Environment Agency. The Leeds City Region Enterprise Partnership, Sedgwick, GJB Consultancy, Upper Calder Valley Renaissance, Ambiental, and the Defra Task Force were also key collaborators of this research.

The Yorkshire Integrated Catchment Solutions Programme (iCASP): is a 5-year programme, funded by the Natural Environment Research Council, iCASP projects are designed by partnerships of academics and experts from organisations active in catchment management. More information about iCASP can be found at**:** https://icasp.org.uk/about/

The West Yorkshire Combined Authority (WYCA) brings together local councils and businesses to foster the economy and meet the needs of the communities, helping delivering local priorities in West Yorkshire. It manages a number of programmes and support businesses to grow. More information can be found at: https://www.westyorks-ca.gov.uk/about-us/

The Environment Agency (EA) is a non-departmental pubic body with responsibilities concerning the protection and enhancement of environment in England. More information can be found at:

https://www.gov.uk/government/organisations/environment-agency/about#who-we-are

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Abbreviations

BEIS	Department for Business, Energy and Industrial Strategy
EA	Environment Agency
ESRC	Economic and Social Research Council
FD	Final demand
FRMA	Flood Risk Management Authorities
GVA	Gross Value Added
iCASP	Yorkshire Integrated Catchment Solutions Programme
LAs	Local Authorities
LEP	Leeds City Region Enterprise Partnership
LIS-B	Insurers, lenders, surveyors and brokers
ONS	Office for National Statistics
PFR	Property flood resilience measures
REM	Regional Econometric Model
SMEs	Small and medium sized enterprises
TAEC	Tool to assess economic costs of flooding on SMEs
TAER	Tool to assess effective flood resilience of SMEs
UCVR	Upper Calder Valley Renaissance
UKRI	United Kingdom Research and Innovation
WYCA	West Yorkshire Combined Authority
Y&H	Yorkshire and the Humber

1 Executive summary

Background

Flooding is the UK's main climate-related threat. Small and medium-sized enterprises (SMEs) represent an essential fabric of our communities by providing employment, goods and services. As such, when SMEs are impacted by flooding, the effects are evident across our towns and cities. The impact of floods on this type of businesses and the economic effects on the local and regional communities is not well understood (Sakai, 2020). Particularly, indirect impacts are rarely considered in economic assessments of SMEs affected by flooding. Having detailed information on the economic costs of flooding can help to better understand the full impact of flooding events. With this understanding, Local and Regional Authorities (LRAs) could develop more informed economic cases to secure investment to reduce flood risk.

In addition, SMEs require insurance, as well as access to finance in order to expand their activities, get a mortgage, or just continue with their businesses. Lenders usually require insurance to be in place. As part of this process, surveyors are often involved to assess and verify the condition faced by SMEs. Insurers, lenders, surveyors and brokers (LIS-Bs) constantly make judgement calls to either or not provide insurance and/or finance. There is a knowledge gap in the understanding of the level of risk that the SMEs' sector entails and on the effectiveness of different strategies adopted by SMEs to decrease their flood risk (e.g. resilience works, business continuity plans). This gap generates uncertainty, which can affect access to finance or the affordability of insurance for SMEs in flood risk areas.

Scope and objectives:

This project bridges the knowledge gaps identified by Sakai (2020) in relation to I) the economic costs of flooding on SMEs and II) the effective strategies, including property flood resilience (PFR) measures, that SMEs take to protect themselves from flooding.

Two tools were co-developed with the project's partners and other stakeholders. On the one hand, TAEC (tool to assess economic costs) allows assessing the direct financial costs and wider indirect economic costs of flooding on SMEs. This facilitates the preparation of more robust business plans and strengthen the case when lobbying for additional funds to be better prepared for future flooding events. On the other hand, TAER (tool to assess effective resilience) allows a better understanding of the

flood risk faced by SMEs and of the effectiveness of the measures and strategies that have been adopted by them to reduce their risk. This improves LIS-Bs' confidence that risk is accurately priced, and that flood risk is properly managed by SMEs.

What TAEC and TAER can do? With the help of project partners, both tools were piloted. TAEC focused on the latest 2019/20 Winter flood incidents. TAER was piloted by 3 professional surveyors (Sedgwick) and applied to 6 SMEs located across Yorkshire and the Humber.

Understanding Information Needs

Local authorities

To develop the Tools, first, a survey was carried out among local authorities (LAs), including flood risk managers, across Yorkshire and the Humber to identify information needs related to the economic costs and other aspects concerning SMES. The survey results show that LAs require information about:

- Economic impacts of flooding on SMEs, which are not appropriately incorporated in business plans of flood alleviation schemes. Current information available to LAs is not adequate to estimate the impacts of flooding on SMEs.
- Type of support from LAs that SMEs need before, during and after a flooding event.
- Number of times that SMEs have been affected by flooding.
- Number of days that SMEs had to close as a direct result of a flooding event.
- Issues that prevent SMEs from having flood insurance.
- Strategies that SMEs have adopted to prevent future flooding impacts.
- Actions that SMEs have taken when there is the imminent warning of a flood event.
- Strategies or improvements undertaken by SMEs that have been useful to recover after a flood event.

Lenders, insurers, brokers, and surveyors (LIS-Bs)

To extract LIS-Bs' opinions, an online survey was conducted. It aimed to: 1) identify LIS-Bs information needs regarding SMEs and their flood impacts, and to 2) explore LIS-Bs preferences on TAER -laying the foundation for the tool's co-creation process. In summary, the survey results show that LIS-Bs require information about:

- SMEs' past experience with flooding and recovery, and their motivation for obtaining flood insurance.
- Actions SMEs have taken to protect themselves.
- Economic values of the damages, the sources of important damages, and the actions that have been taken to mitigate such damages.
- Magnitude of the damages and the recovery process.

The survey also asked the respondents to suggest, based on their own experience, some of the best strategies that an SME can implement to better manage and reduce their flood risks. Overall, the main suggestions indicate that SMEs need to:

- Increase their awareness of flood risks.
- Increase their engagement with trusted sources of knowledge, as well as community and neighbourhood.
- Install flood-resilience measures.
- Create and maintain a flood plan.

In relation to the development of TAER, the top 3 outputs that respondents would like the tool to produce are:

- Effectiveness of property level protection installed.
- List of flood-resistance measures that SMEs have installed.
- List of flood-recoverability measures that SMEs have installed
- Assess the main areas, as well as magnitude, of economic losses due to flooding.
- Evaluate the employees' knowledge of flood protection measures and strategies.
- Evaluate the effectiveness of community-level flood defence preparations.

Finally, the survey results show that 80% of the respondents believe a resilient SME should possess the ability to prepare and respond to a natural disaster, such as flooding, and the ability to cope, adapt, renew and learn to become more resilient after a disaster.

Developing the tools

TAEC

The co-production of the tool followed several stages:

- A survey to identify the information needs of LAs on 26/05/2020.
- Literature review to identify the existing methods used to assess direct and indirect costs of flooding on SMEs.
- Data collection from LA partners and publicly available databases.
- Survey sent out to SMEs to assess direct financial costs.
- Model development in collaboration with LA partners
- Pilot run using Calderdale data.

TAER

LIS-Bs and other stakeholders were invited to contribute to the co-development of TAER at various stages throughout the process. Their insights and feedback were collected using a survey, semi-structured interviews, and a focus group discussion.

- A total of 18 semi-structured interviews with LIS-B stakeholders were conducted during September and October 2020 to assess their requirements for the resilience assessment tool.
- An online focus group with 5 representatives of insurers, surveyors, brokers and lenders was held to critique the structure, function, and features of the tool developed based on the data gathered through interviews with LIS-Bs.
- Development of a prototype based on the interview findings.
- Pre-pilot to test tool with several SMEs to further tailor the content and format to their preferences and needs.
- Pilot based on 6 case studies.

Piloting the tools: Results

TAEC (highlights)

- 135 SMEs were surveyed, located in 15 districts across Yorkshire and the Humber, belonging to 17 different sectors.
- Around 53.2% of businesses reported that the worst flood event they have experienced took place in the last 6 years.
- In terms of the direct losses, the larger the business, the larger the average loss in revenue from the 2019/2020 winter floods. However, when we also take into consideration the average monthly turnover it becomes clear that the smaller businesses suffer the most losses in relative terms.
- The most common types of damage experienced by businesses were related to access due to disruptions in roads, motorways, etc. (68%), followed by temporary closure of premises (56%).
- In Calderdale, during the winter of 2019/2020 the floods caused £43.3 million of direct losses, with an estimated £25.1m of indirect losses
- In Calderdale, the results show that for every £1 of direct losses, there was a further £0.63 of indirect losses.
- The 2019/20 Winter floods caused premises to close for 13 days on average, businesses to lay-off 57 employees, and in the first month after the event, a 31% reduction of their monthly sales.
- Businesses reported that the most useful type of support before an imminent flood incident is Grant Aid from Local or Central Government, and advice from business support organisation during and after a flood. 38.9% of the businesses that answered the questions (N=90) have flood insurance, whilst those that do not have insurance mostly reported that it is not worthwhile (41%) or that they could not get a quote at all (39%). 68% of the businesses surveyed were confident of having reconstructed their business after a flood event in a way that is now better equipped to face another flooding event. At least 44.4% and 43.7% or more businesses reported having taken measures to make their properties more recoverable and more resistant to flooding respectively.

TAER (highlights)

- All the case studies experienced flooding. Case studies 1, 2 and 6 have been actively educating themselves, communicating with local authorities and organisations, and participating in flood advocacy. They especially found that the

materials in the Learning Suite (Module I) were not useful for them to learn more about flood risks, protection, resilience and recovery. However, all the case studies agreed that it would be a useful resource for SMEs that rarely experience flooding or those that have not experienced it before.

- Participants suggested that Module I (the Learning Suite) should include: more information on professional flood risk assessment, as well as potential costs of damages that flood can inflict in the future (especially since it is difficult to predict climate change effects on extreme flooding and associated losses in income).

- In relation to Module II (SMEs self-assessment and record-keeping), participants commented that the tool was "very clear, easy to use and thought provoking", and that it helped them to better understand their own resilience and keep a record of the measures and strategies they employed. It was mentioned that the tool needs to accommodate both SMEs that are owning and leasing their business premises. A simple traffic-light rating system was developed to indicate the resilience level of an SME. Some participants were surprised by the rating they received as being lower than they expected.

- Regarding module III (professional building resilience and flood risk assessment), surveyors expressed that it is important for the insurers to have the data on the design depths and the level of various types of flood risk.

- All of the cases in the pilot study have not been able to obtain flood insurance and are located in an area prone to at least one type of flooding.

- Participants found that information of (TAEC) helps to better explain the situation of the SMEs under evaluation, pointing out the need for integrating the two tools (TAER and TAEC).

- The combined information from Module II and Module III gives the underwriters a better sense of an SME's attitude. Underwriters can use the flood risk and building resilience assessment done by a surveyor to evaluate whether an SME has taken actions to manage those identified risks.

- Going forward, we need to actively engage with brokers, because they can play a major role in explaining, elaborating, and clarifying to insurers the information SME provided using the tool and, at the same time, helping SMEs to bring clarity and context to their information.

2 Introduction

According to the latest UK Climate Change Risk Assessment (2017) flooding is the main climate-related threat facing the UK. Flooding is rarely good business, and for small and medium sized enterprises (SMEs) it is sometimes a matter of survival. SMEs make up 99% of the Yorkshire business base and provide employment, goods and service. They represent an essential fabric of communities. As such, when SMEs are impacted by flooding, the effects are evident across our towns and cities.

The floods of 2013/14 resulted in losses to the business sector of around £831 million in overall costs (FSB, 2014). The 2015 Boxing Day floods caused almost £47 millions of losses in Calderdale alone, whilst the knock-on effects across the regional economy amounted to £179 million pounds (Sakai et al., 2016). Flooding can destroy the assets of a company, but it may also bring disruptions in the supply of raw materials or of public services, modify the demand of products, diminish worker productivity, etc. All these indirect impacts are rarely considered in economic assessments of SMEs. All these interlinkages mean that if SMEs are affected by flooding, then the future prosperity and development of towns and regions can be compromised. Reducing the flood risk and increasing the resilience of SMEs is imperative, it is evident that the impact of floods on this type of organisations is under researched and not well understood (Sakai, 2020).

The Leeds City Region Flood Review was published in (2016) and developed in partnership between the West Yorkshire Combined Authority, LEP, Leeds City Region local authorities, Yorkshire Water and the Environment Agency. The Review and its 19 recommendations aim to implement a more consistent and effective approach to both flood-risk management and mitigation, and the response to future flood events across the City Region. Recommendation 3 of the Review relates directly to this project – identifying the need for a robust formula for modelling the indirect economic impact of flooding events.

The lack of knowledge about the economic impacts of flooding on SMEs brings significant challenges, Figure 1 shows the information needs of the target users of this project. If SMEs do not know the extent of the damage that flooding can exert on them, it is more likely that they will take a *wait and see* approach; i.e., they will wait until they are badly hit to take action. Not taking effective flood mitigation actions decrease the resilience of not only the SMEs themselves, but also of entire towns. SMEs

belong to multiple spheres (producers, suppliers, customers, etc) and their importance in their towns is recognised by the government. For instance, Central Government paid out over £250 million as part of the support package of up to £5,000 grants for both homes and businesses to recover from the 2015 winter floods (Bonfield, 2016). While welcomed, those schemes could be seen as merely palliatives, as there is no evidence of impact in terms of mitigating future flood risks. Furthermore, they might be creating a 'moral hazard' if businesses expect to receive those grants every time they are flooded (Sakai, 2020).

Having detailed information on the economic costs of flooding can help to better understand the full impact of flooding events. With knowledge and understanding of the situation, Local and Regional Authorities could develop more informed economic cases to secure investment to reduce flood risk. For instance, in April 2016, a report on the economic impact of the 2015 Boxing Day floods was produced by the University of Leeds in collaboration with Upper Calder Valley Renaissance (UCVR) and the Calderdale Council. The report provided information about SMEs in Calderdale, identified support needs for SMEs in the immediate aftermath of the flood, assessed recovery following both the 2012 and 2015 floods, and estimated the financial loss to the local area and regional area. The report provided vital evidence on the economic impact and was influential in making the case for financial support for the borough. It also was valuable to identify points of intervention as, for example, the case of lack of access to insurance by SMEs.

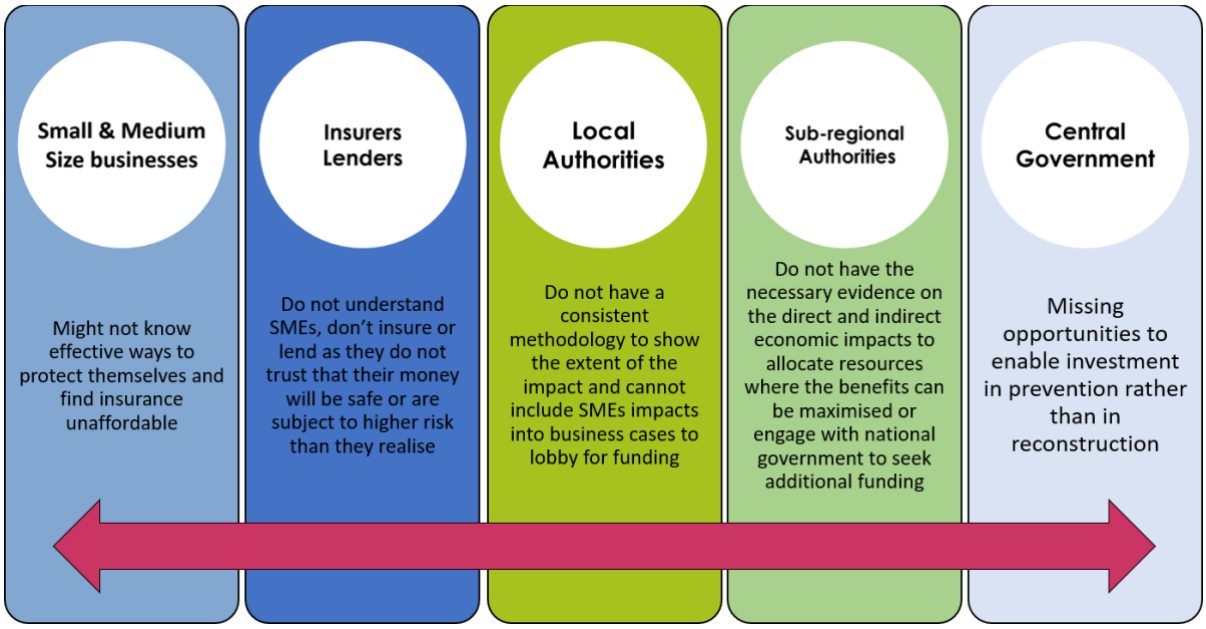

Figure 1 information needs of the target users of this project

Having flood insurance is one flood risk management strategy. However, lack of knowledge about the economic impacts of flooding on SMEs also has implications in this regard. In addition, insurance is also needed when SMEs require access to finance to expand their activities, get a mortgage, or just continue with their businesses. Lenders usually require insurance to be in place. As part of this process, surveyors are often involved to assess and verify the situation faced by SMEs. Insurers, lenders and surveyors constantly make judgement calls to insure/lend, or not, to SMEs. Those decisions are based on the understanding of these actors on the risk that businesses represent. Sakai (2020) show that there is a knowledge gap in the understanding of the level of risk that the SMEs' sector entails. Insurers (excluding flood specialist brokers, which are few) largely do not have data on the economic costs of flooding to SMEs and do not understand the realistic flood risk reduction steps that heterogeneous SMEs can undertake and their implications for risk.

Unlike households or vehicles, where common assets can be insured, thereby limiting insurer's risk, SMEs have different products and operate in different ways. The lack of understanding generates uncertainty, which is reflected in high insurance prices for SMEs in flood risk areas. This, in many cases, means that they do not take out such insurance, affecting also potential lending processes. Insurers and lenders are keen to better recognise and reward the increased resilience and reduction in risk, thus creating greater awareness and a market for property-level resilience (British Insurance Brokers' Association 2016 survey on how flood resilience measures are viewed in the insurance market as cited in: Bonfield, 2016). However, there is a gap in the understanding of the effectiveness of different strategies to decrease flood risk (e.g. resilience works, business continuity plans). It is not only that these have not been tested against a real flood, but there is also a lack of trust and understanding that SMEs are protecting themselves and that the resilience measures, for instance, have really increased their resilience (Sakai, 2020).

3 Scope and objectives of the project

As stated in the previous section, there is imperfect information about the situation of SMEs and flooding, which in turn impedes advancing flood preparedness. Our objective in this project was to bridge the knowledge gaps in terms of I) the direct and indirect economic costs of flooding on SMEs and II) the effective strategies, including PFR, that SMEs take to protect themselves from flooding (See Sakai, 2020). Using mixed methodologies, we co-produced knowledge with partners and other stakeholders resulting in synergistic outcomes. The data is qualitative and quantitative, both providing a deeper understanding on the situation of SMEs and flooding.

The Table below shows the number of participants and methods used in this project.

Table 1. Number of participants and methods used.

Description	**Total**
Semi-structured Interviews with: Lenders (3), Insurers (8), Surveyors (3), Brokers (2), other relevant professions (2) and SMEs (6)	22
Meetings with partners - LRAs (10), LIS-B (11), Project presentations and meetings with LRAs (7)	25
Webinars with: LRAs (1), LIS-B (2)	3
Focus group with LIS-B (1)	1
Surveys with: LRAs (1), LIS-B (1), SMEs (135)	137
Workshops with: LIS-B (1)	1

Deepening our understanding on the information needs

First, we deepened our understanding of the information needs that LRAs and LIS-B have regarding SMEs and flooding by conducting two surveys. This allowed us a better comprehension of the current landscape and what was more relevant to them in terms of SMEs and flooding. We also undertook meetings with regional partners and a literature review to understand the current assessment methods and needs on the indirect and direct costs of flooding on SMEs. Quantitative datasets obtained by Dr Paola Sakai's in previous studies, were mined to extract the information that LIS-B wished to know to increase their understanding on SMEs and flood incidents. Outputs of this work were presented in two webinars and the main results are presented in Chapter 4.

Development of tools to carry out future assessments

We focused our efforts to co-develop two tools that could bridge the future knowledge gaps. On the one hand, we developed TAEC for LAs to carry out future economic assessments of the impact of flooding on SMEs in a consistent and timely way. This would allow the preparation of more robust business plans and strengthen the case when lobbying for additional funds to be better prepared for future flooding events. To develop TAEC, we collected data for almost all the districts across Yorkshire and the Humber. Modelling was made to construct a regional model that can be used to assess the economic costs of flooding on SMEs.

On the other hand, we co-developed TAER to improve LIS-Bs' confidence that risk is accurately priced, and that flood risk is properly managed by SMEs. This will allow them to explore the market in flood-risk areas and offer more accurately priced insurance products based on a better understanding and trust of the risks that the SMEs sector in those areas represent. TAER's development followed a sequential process where first, through semi-structured interviews with LIS-B, we pinned down the information that tool needed to provide. Having included their views, a focus group was carried out to tune the tool and contrast LIS-Bs views. After including that feedback, TAER followed another round of interviews to tailor it to two of its users: surveyors and SMEs.

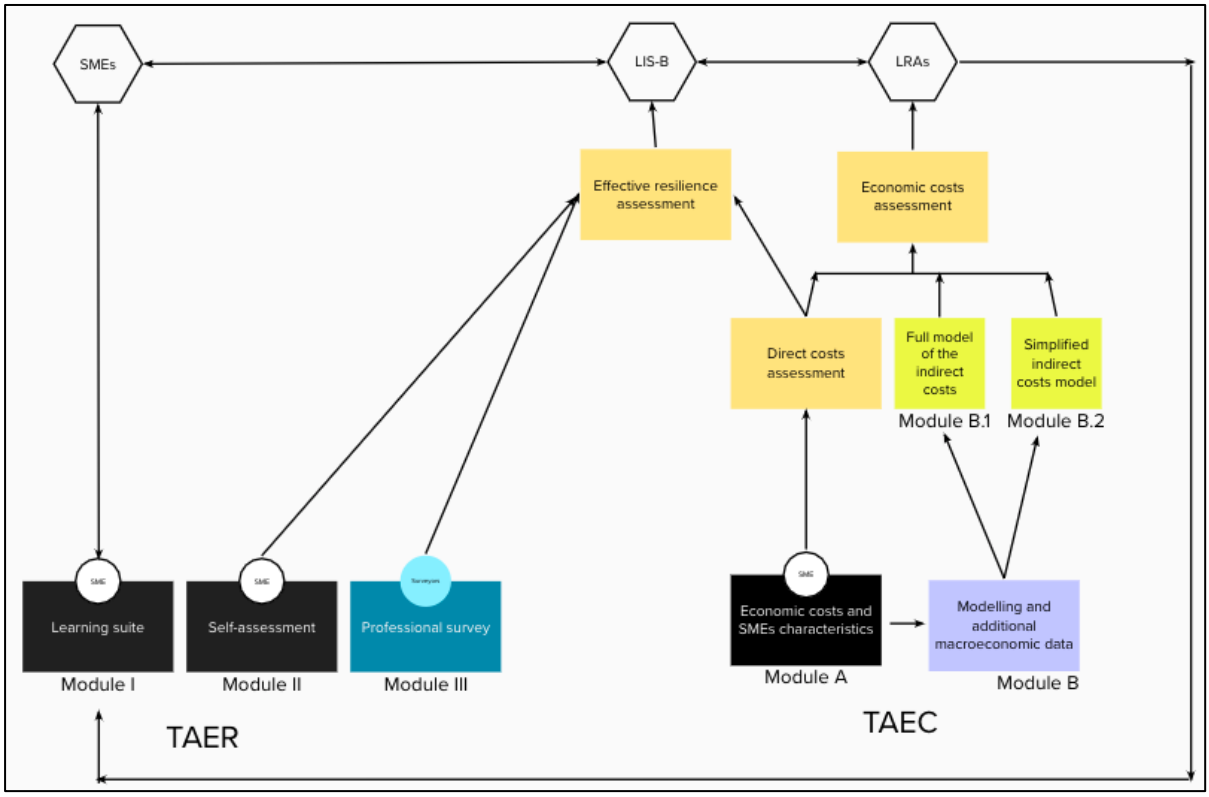

Figure 2. Schematic of the tools showing the inputs and outputs, and how the tools can be linked.

What TAEC and TAER can do?

With the help of our partners, we piloted both tools. TAEC was focused on the 2019/20 Winter flood incidents. Through a survey questionnaire, we collected data from 135 SMEs in 15 Yorkshire and Humber local authorities[1]. The survey results served as an input to our regional model. We assessed the direct and indirect economic costs, as well as other essential information related SMEs' flood protection and resilience. The results are presented in chapter 6, while training to LAs will be pursued in the future to teach them how to use the tool.

We piloted TAER with 3 of our partner's professional surveyors (Sedgwick) and applied to 6 SMEs located across Yorkshire and the Humber. A new partner emerged (Ambiental), who provided additional information on the 6 cases. The results that emerged from TAER were presented in a workshop to find out to what extent the information provided was fulfilling the information needs of LIS-Bs and to what extent this tool was helping them to increase their trust and understanding on the risk management strategies that SMEs undertake to protect themselves. The results of this workshop are presented in chapter 5.

Outreach and beyond

We aim to advance SMEs flood resilience across Yorkshire and the Humber. The project seeks to deliver social and economic benefits. These benefits can be achieved (1) by avoiding direct and indirect losses and damages to SMEs due to flooding; (2) by using information on these losses to enhance the business cases of local and regional authorities; (3) by building SMEs' coping and adaptive capacities through more informed preparedness, and; (4) by helping to provide higher access to loans and insurance coverage thanks to a greater understanding and trust of LIS-B

[1] Due to the pandemic, we faced many challenges in the data collection as SMEs and Local Authorities were overstretched with the pandemic, and with some additional flood incidents that happened in 2020. We got together with the FRMs and developed a number of strategies to encourage SMEs to answer the survey.

on the flood-risk management strategies taken by SMEs. Our focus has been on Yorkshire and the Humber, but we also aim to engage with other LAs at flood risk. We also wish to influence sub-regional and national agendas, as well as to inform the next Climate Change Risk Assessment to develop new programmes and policies, so areas at flood risk can increase their flood resilience.

4 Understanding Information Needs

4.1 WP1 Local Authorities Information Needs

A survey was carried out with Flood Risk Management Authorities (FRMAs) in Yorkshire and the Humber (Y&H) to better understand what they were interested in knowing about, not only on the economic costs, but also on other aspects related to SMEs and flooding. In the survey, we provided a list of information that included key elements that influence the way in which SMEs can cope with a flood event. These key elements were identified in Sakai's previous studies (Hernández, 2013; Sakai et al., 2016; Sakai, 2020).

A total of 10 responses from 9 councils were obtained (Bradford, East Riding, Hull, Kirklees, Leeds, Rotherham, Scarborough, City of York, Rotherham and Wakefield). The information priorities of LAs regarding flooding impacts over SMEs varied to a certain degree. However, there was a consensus regarding how limited the information is about flooding impacts and recovery available for LAs. For example, information about flood insurance and the strategies that SMEs have undertaken in order to recover after a flood, was also mentioned as of concern.

Out of all responses, only one LA considered that they have been able to include the economic costs of flooding on SMEs appropriately into the business plans of the flood alleviation schemes, while most respondents answered that it was not included or not appropriately included. However, there was a recognition that this information is key to prepare a business case submission. Importantly, the available information to LAs on indirect economic costs is not adequate to estimate the impacts of flooding to SMEs (See Figure 3).

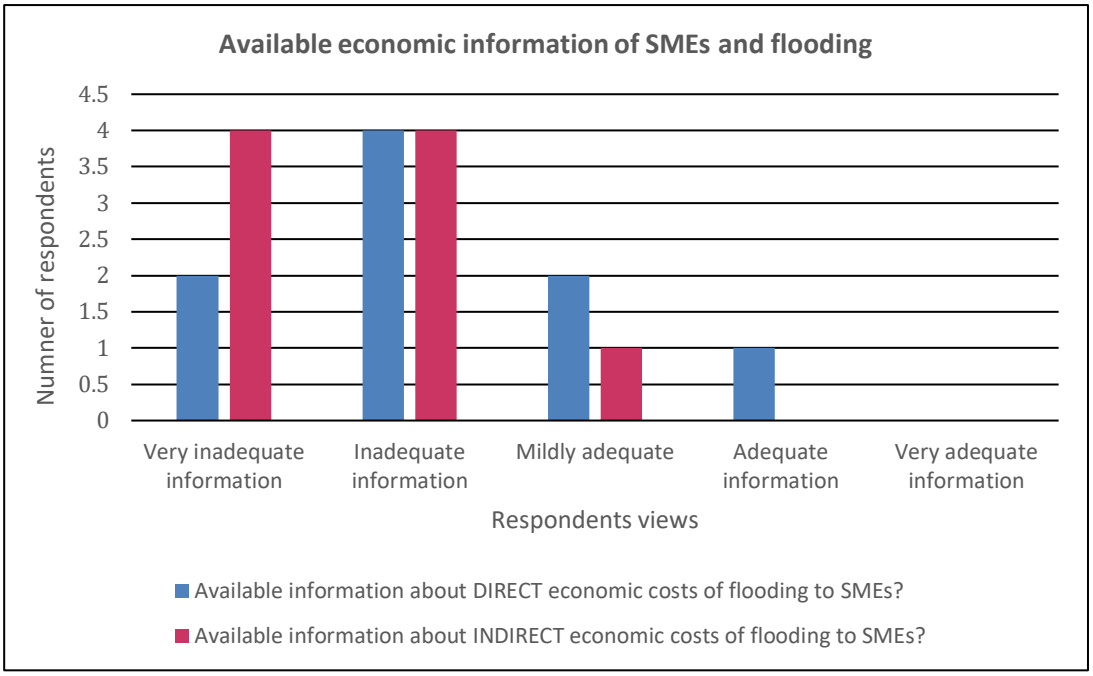

Figure 3. Views regarding availability of the economic information of the impacts of flooding over SMEs.

The information needs about general SMEs experiences with flooding showed some variations. However, LAs consider the following information as the most useful for them: 1) Type of support from local authorities that SMEs need before, during and after a flooding event, 2) Number of times that SMEs have been affected by flooding, and 3) Number of days that SMEs had to close as a direct result of a flooding event.

Regarding insurance, LAs are interested in the insurance issues that SMEs might have experienced and the reasons why SMEs don't have insurance. However, the issues that the surveyed LAs are more interested in are: (1) whether SMEs currently have flood insurance, and (2) whether SMEs consider that they are now better equipped to face future flooding events of a similar magnitude (See Figure 4).

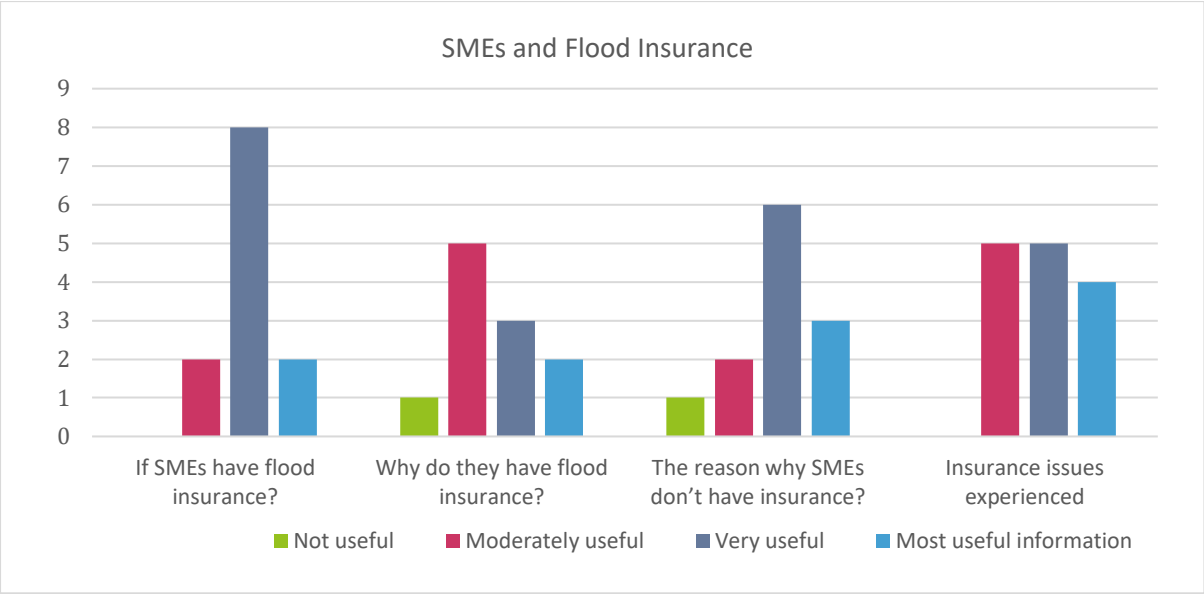

Figure 4. Most useful information regarding SMEs flood insurance for LAs.

Regarding SMEs strategies and planning to prepare for extreme weather events, LAs were particularly interested in the following: 1) strategies that SMEs have adopted to prevent future flooding impacts (e.g. to develop a flood business continuity plan, subscribed to flood warnings, changed to more reliable suppliers); 2) actions that SMEs have taken when there is an imminent warning of a flood event (e.g. re-arrange deliveries with suppliers, talk to employees/customers), and; 3) strategies or improvements undertaken by SMEs that have been useful to recover after a flood event.

Local authorities were asked about the usefulness of knowing the business's own perception of risk though two questions. The first one asks whether "*businesses perceive they are at risk of going out of business as a result of the impact of a flood*" (44.4% considered moderately useful, while 55.6% considered very useful). The second one enquires whether "*businesses consider they are better equipped to face another flood event of a similar magnitude*" (30% considered moderately useful and 60% considered very useful).

The survey also contained a set of open questions in order to capture other concerns. These provided a new angle to the questions that we introduced in the SMEs survey. For example, comments such as "*Please focus on all types of flooding and not just steep-sided catchments with obvious risk*" suggest that it is important to include the different types of flooding. With regard to the turnover and employment costs, LAs mentioned that it would be useful to have previous year's figures to make comparisons.

In general, it was evident that LAs were interested in the strategies that SMEs have taken to minimise flooding, in the specific actions that SMEs can be taking to increase their resilience, and the challenges that they find in the process.

Information of the operation of SMEs can be vital for the decision-making process of LAs. We presented nine categories of information regarding SMEs operation and asked LAs to rate its usefulness for decision making. The categories marked as most useful were: (1) How many employees do affected SMEs have? (2) Do SMEs own their premises? (3) How many home-based businesses were affected? (4) How much is the annual wage bill of affected SMEs; and (5) how much is the annual turnover of affected SMEs? (See Figure 5)

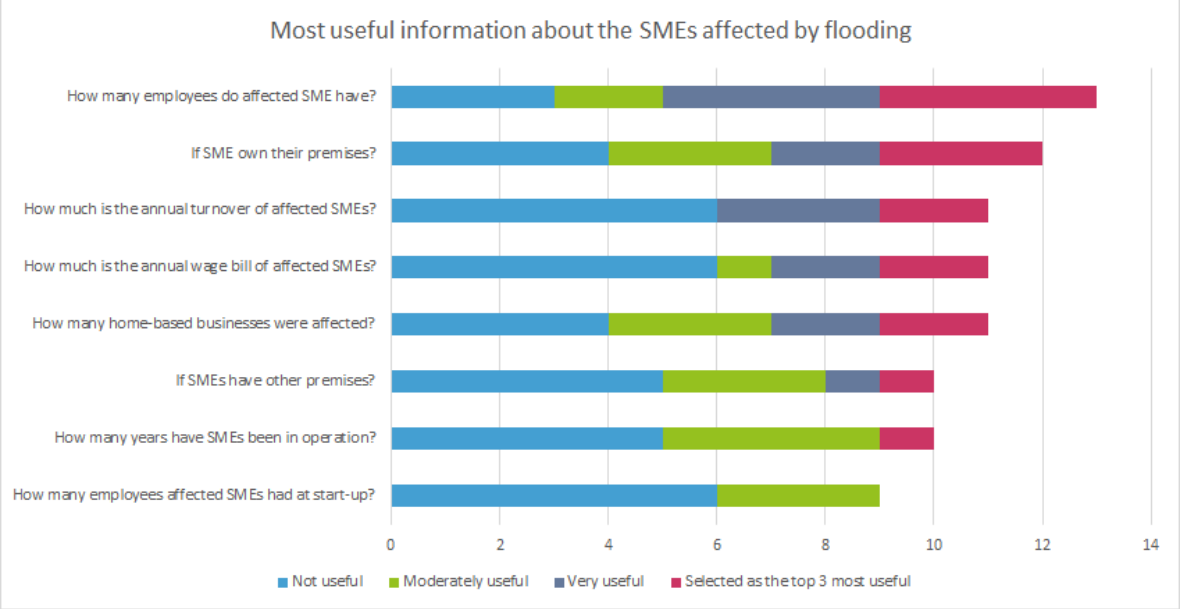

Figure 5. Most useful information about the characteristics of SMEs affected by flooding

Regarding the LAs perception of the timeliness, consistency, and coordination of the current assessment of the direct and indirect economic costs of SMEs following flooding events across Yorkshire and the Humber, as it can be seen in Figure 6, most respondents considered that the information was completely or somehow inadequate.

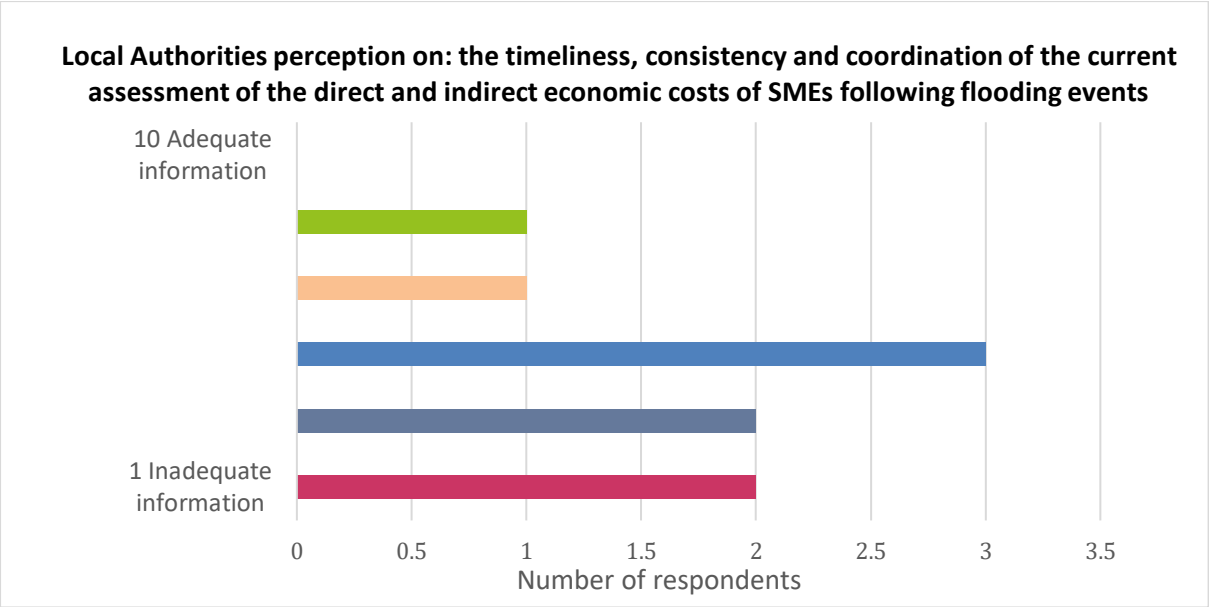

Figure 6. LAs Perceptions of the timeliness, consistency, and coordination of the current assessment of the direct and indirect economic costs of SMEs following flooding events across Yorkshire and the Humber.

4.2 WP2 Lenders, insurers, surveyors and brokers' information needs

4.2.1 Developing the survey

To elicit the thoughts and opinions of lenders, insurers, brokers, and surveyors (LIS-B), we conducted an online survey that consisted of two sections. The first section aimed to identify the information needs of LIS-B regarding SMEs and their flooding impacts. In this section of the survey, we asked the participants to identify their information needs, based on information from existing datasets, regarding SMEs' flood risks, SMEs' response and recovery strategies from a flooding event, and SMEs' flood insurance situations. We then asked whether the information is more relevant to the participants for 1) increasing their understanding of SMEs, 2) increasing their engagement with SMEs, 3) making decisions to offer flood insurance to SMEs, and 4) designing new products for SMEs.

The second section aimed to explore their user preferences on the tool and to lay the foundation for the co-creation process of the tool. We asked the participants how important and useful it is for the tool to produce outputs on: 1) presence of recoverability and resistance measures at a property, 2) performance level of flood-resilience measures, 3) historical records to demonstrate signs of improvement, or whether underperforming measures are fixed or replaced, 4) level of understanding

of the rationale behind the measures implemented, and 5) community-level resilience.

4.2.2 Confidence and awareness

Among the survey respondents, 5% work with SMEs exclusively, 60% frequently, and 35% occasionally. In terms of experience with flood insurance, 60% of participants have extensive experience, while 30% had dealt with specific issues with flood issues occasionally and 10% had no experience. According to respondents, the main factors that would lead to an increase in the uptake of flood insurance by SMEs included: offering affordable insurance that considers the implementation of flood proofing measures, making sure that SMEs understand the value of insurance, and offering alternative or innovative products to SMEs.

Among the respondents, 65% reported to have high levels of awareness of the economic consequences of flooding on SMEs (Figure 7). The respondents were also asked to rate their confidence level on the effectiveness of resilience works SMEs implement to reduce the financial impact of a flood (Figure 8). The mean score was 2.15. The two main factors that would boost their confidence level are having evidence and documented proof, apart from accurate, adequate, and "approved" information, as well as making sure that SMEs understand the information they have accessed and the measures they have installed.

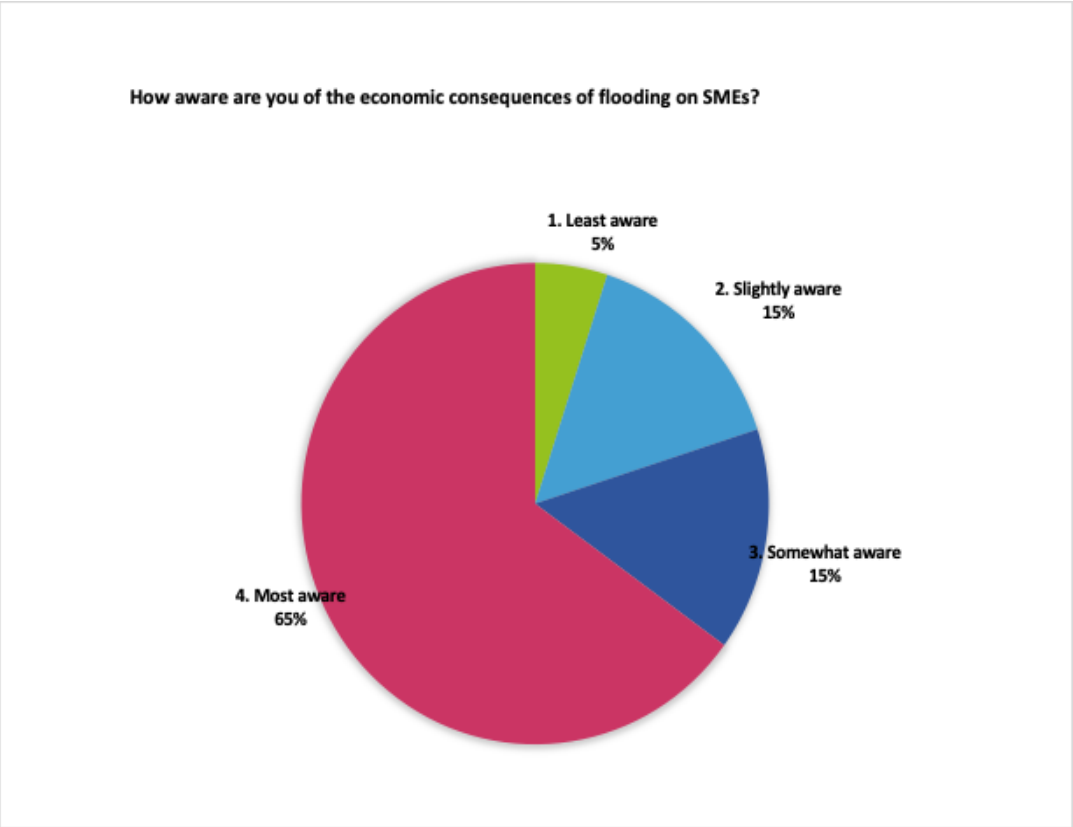

Figure 7. Awareness level on the economic consequences of flooding on SMEs.

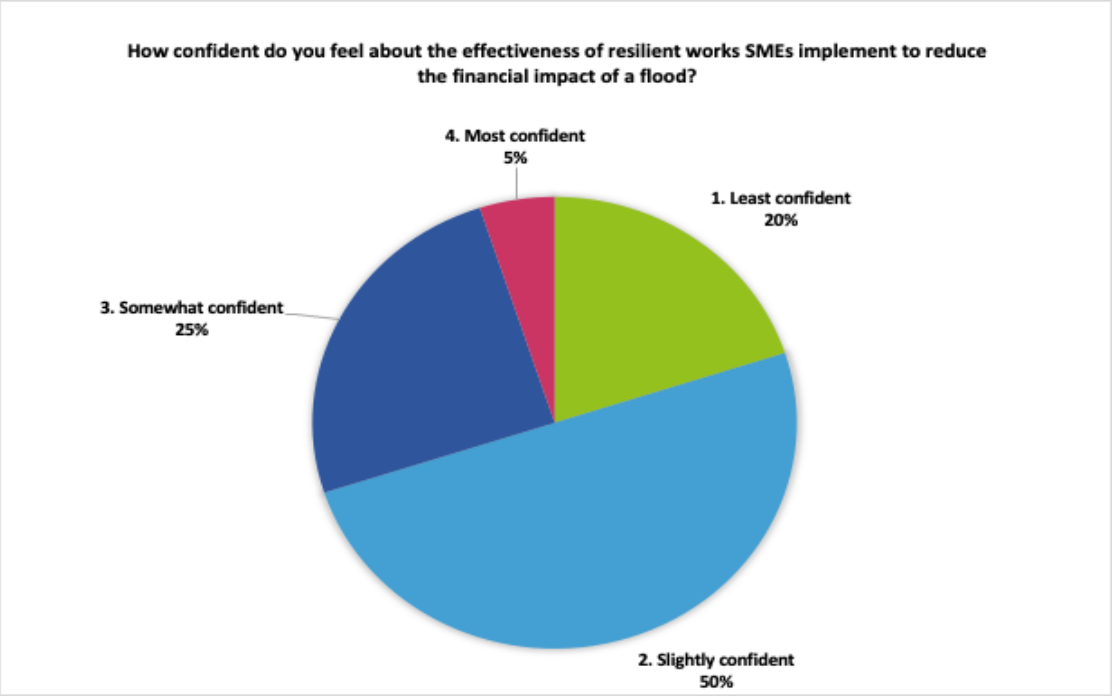

Figure 8. Confidence level on the effectiveness of resilience works SMEs implement to reduce the financial impact of a flood.

4.2.3 Information needs

In the survey, we provided a list of the existing information (i.e. variables) obtained from Sakai's previous studies (See: Sakai, 2020; Sakai et al., 2016; Hernandez, 2013). This list was carefully designed by the leading researcher, who in previous studies has drawn these variables from the literature and tested them as key elements that influence the resilience of SMEs. Respondents of the survey rated the list of variables according to their views; for example, increasing the respondents' understanding of SMEs. The complete list of the rated most relevant information is shown in Table 2.

Table 2. Top 5 relevant information about SMEs and flooding.

The top five relevant information for **increasing** the respondents' **understanding** of SMEs	Strategies that businesses adopted because of their experience of flooding; Why SMEs choose to have flood insurance; How long SMEs remain closed; How much time it takes SMEs to recover; Number of employees being laid off as a consequence of a flood event.
The top five relevant information for **increasing** the respondents' **engagement** with SMEs	How SMEs prefer to receive flooding advice; Improvements that SMEs have implemented after a flood; Types of resilient measures and strategies SMEs have put in place; Strategies that businesses adopted because of their experience of flooding; The most prevalent problems SMEs are having with their flood insurance.
The top five relevant information for making decisions to **offer insurance** to SMEs	SMEs' economic losses in terms of monetary values due to flooding; Where SMEs suffered the most damages in terms of monetary values; Improvements that SMEs have implemented after a flood; Types of resistant measures SMEs implemented; Types of recoverability measures and strategies SMEs have put into place.
The top five relevant information for **developing new products** for SMEs	Where SMEs suffered the most damages in terms of monetary values; SMEs' economic losses in terms of monetary values due to flooding; How much time it takes SMEs to recover; Amount of external support the SMEs received to recover and how they used it; Percentage of SMEs having reduced premiums after implementing resilience measures

In summary, the respondents would like to have a deeper understanding of SMEs' past experience with flooding and recovery, and their motivation for obtaining flood insurance. To engage with SMEs more effectively, most of the respondents stated that it was important to know more specifically the actions SMEs have taken to protect themselves. In relation to offering flood insurance to SMEs, the respondents were interested in the economic values of the damages, the sources of important damages, and the actions that have been taken to mitigate such damages. Finally, in order to develop new products for SMEs, the respondents wanted to know about the magnitude of the damages and the recovery process.

4.2.4 Best strategies

The survey also asked the respondents to suggest, based on their own experience, some of the best strategies that an SME can implement to better manage and reduce their flood risks. Overall, the main suggestions indicate that SMEs need to:

increase their awareness of flood risks.

increase their engagement with trusted sources of knowledge, as well as community and neighbourhood.

install flood-resilience measures.

create and maintain a flood plan.

4.2.5 Resilient SMEs

As seen in the literature, SME resilience can be measured and interpreted based on different factors. In this project, we are relying on strong stakeholder engagement to maximise the value of the resulting product. Therefore, to co-develop a tool for assessing SMEs' effective resilience, it was crucial for us to have a good understanding of the stakeholders' perspectives on the key factors, as well as their preferences on the objectives, outputs, and presentation of the resilience assessment tool. The last section of the WP2 survey served as a scoping point for the discussion with our stakeholders during further interviews.

The five themes the survey explored are:

1. Performance level of flood-resilience measures.
2. Presence of recoverability and resistance measures at a property.
3. Historical records to demonstrate signs of improvement, or whether underperforming measures are fixed or replaced.

4. Level of understanding of the rationale behind the measures implemented.
5. Community-level resilience.

The top 3 outputs that respondents would like the tool to produce are: 1) the effectiveness of property level protection installed, 2) list of flood-resistance measures the SMEs installed, and 3) list of flood-recoverability measures SMEs installed, in that order. These results show that it is most important for the respondents to know the presence and the performance of property-level protection measures (the first two themes explored in the survey).

Under the theme of historical records used to demonstrate signs of improvement, the respondents would like to assess the main areas and the magnitude of economic losses because of the flood. In terms of the level of understanding of the rationale behind the measures implemented, the respondents chose to evaluate the employees' knowledge of flood protection measures and strategies. In the last theme of community level resilience, the respondents would like to evaluate the effectiveness of community-level flood defence preparations.

For the development of the tool, TAER, we wanted to understand users' interpretation of resilience with what the tool is measuring. Therefore, we asked the respondents about the attributes that a flood-resilient SME should possess. The resilience of an SME is a dynamic and multidimensional process (Hernández, 2013; Sakai et al., forthcoming). A resilient SME does not stop taking actions once they have recovered and are back in business; they will innovate and learn from their experience to better prepare themselves for any future natural disaster. The survey results show that 80% of the respondents believe a resilient SME should possess the ability to prepare and respond to a natural disaster, such as flooding, and the ability to cope, adapt, renew and learn to become more resilient post-disaster.

5 Developing the tools

5.1 Development of tools: TAEC

The co-production of the tool followed several stages, as can be seen in the figure below. Initially, a survey was conducted in order to identify the information needs of LAs in relation to understanding the direct and indirect costs due to flooding faced by SMEs. We sent out a survey to 16 Local Authorities (LAs) on 26/05/2020 about the information they need to assess the impact of flooding on SMEs (See section 4.1). At the same time, a literature review was undertaken to identify the existing methods used to assess direct and indirect costs of flooding on SMEs. The results of the literature review are detailed below. Once we had identified the needs of the LAs and the most appropriate methods, we collected data from our LA partners and any publicly available data required. The data collected focused on the development of the model, and in collaboration with our LA partners, directed the development of the model in the form of two modules (B.1 and B.2). We then piloted the model using Calderdale as an example district because this location had the most data.

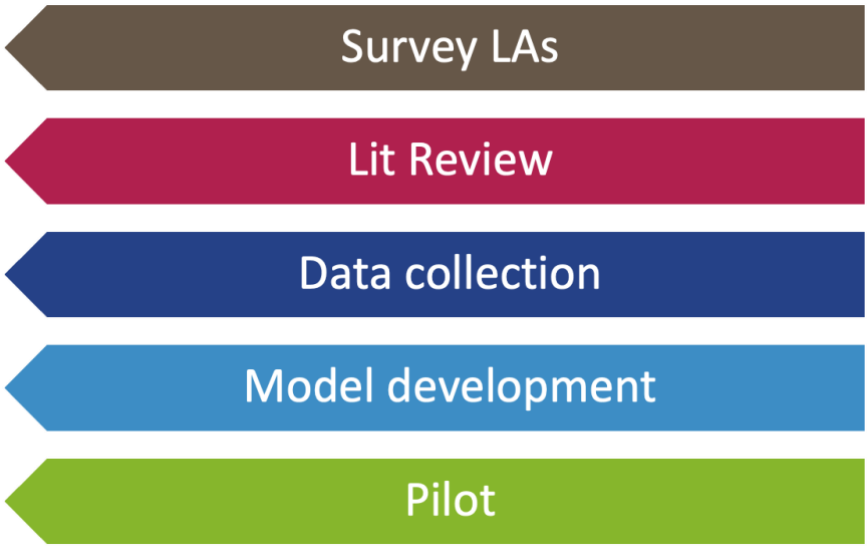

Figure 9. The development of the TAEC followed these stages from top to bottom.

The literature demonstrates that SMEs are more economically vulnerable to flooding and that there has been limited research into the financial and economic damages related to these types of firms, particularly the indirect costs.

We reviewed the literature and found that three methods are used to calculate direct costs:

1. Insurance pay-out method
2. The unit cost (or average) method
3. Depth damage curves

The insurance pay-out (replacement cost) from a flood event can be used to give a simple financial assessment of the direct tangible damages (Gertz et al. 2019). However, some properties can be over or under insured, and not all flooded properties have insurance (Clemo, 2008; Olesen et al., 2017). The unit cost method applies an average loss value for property categories, which can use insurance data, expert knowledge and previous flood event data (Gissing and Blong, 2004; Olesen et al., 2017). The favoured method is the depth damage curves, which take into account the inundation depth of the floodwater and building type (Hammond et al., 2015; Penning-Rowsell et al., 2013; Sieg et al., 2019; Thieken et al., 2009).

We also identified that three methods are commonly used to calculate the indirect costs of flooding.

1. Percentage of direct tangible damage
2. Unit cost method
3. Economic models

Some studies have used a percentage of direct tangible damage to represent indirect costs (Gissing & Blong, 2004; Handmer et al., 2002; Penning-Rowsell et al., 2013). This is a simple method that assumes direct costs are correlated to indirect tangible damages, which Olesen et al. (2017) states is a coarse assumption. The unit cost method applies a sector specific cost to measure the indirect costs (Olesen et al., 2017). It can be calculated by estimating the interruption to production using loss from added value or wage losses (Hammond et al., 2015; Rose et al., 2009). A criticism of the unit cost method is that it is difficult to measure the length of disruption to business (Hammond et al., 2015). Economic models have been used to estimate the indirect costs from flooding (e.g. Hu et al. 2019; Koks et al. 2019; Sieg et al. 2019) and other natural disasters (e.g. Hallegatte, 2008). The Input-Output analysis method is one of the most commonly used, and can be applied at a regional level, which matched this project's needs. It has been used to calculate direct and indirect costs of the 2007 floods in Yorkshire and the Humber (Mendoza-Tinoco et al., 2017), the 2013 floods in Germany (Sieg et al., 2019), and the 2015 floods in Calderdale (Sakai et al., 2016). Input-Output models are built on the idea of the circular flow of money through an

economy (Mendoza-Tinoco et al., 2017, 2020). In the model, businesses (split into sectors) receive inputs from other businesses and then produce outputs for households, government and other businesses (Hammond et al., 2015). The benefit of the Input-Output model's structure is that they are useful in showing how damage from flooding in some sectors can ripple through the economy (Hammond et al., 2015). Data availability will determine the choice of method and is one of the main sources of uncertainty in assessing the cost from flooding (Handmer et al., 2002; Meyer et al., 2013). On top of this, each method has different levels of uncertainty in calculating the indirect costs of flooding. Uncertainties with the data for the Input-Output table used in the tool arise from the data format; i.e., whether the data is at a national, regional or district level.

The literature review, in this sense, allowed us to identify Input-Output analysis as the most adequate method. The following stages of the tool development involved working with our LA partners to develop a tool that would be practical and usable (using information gathered from the LAs survey, section 4.1).

In basic terms, the development of TAEC involved designing its two modules. Module A comprises a survey to acquire data on the economic impact of recent flood events on SMEs in Yorkshire and the Humber (see section 6.1 for survey results). Conducting this survey was important, given that there is often a lack of data at a local scale related to the number of firms affected, the types of damages they suffer, and the different costs and losses they register. Module A also involved collecting additional macroeconomic data at a national, regional and district level (where available) from the Office for National Statistics (ONS), the Department for Business, Energy and Industrial Strategy (BEIS) and our LA partners; e.g., the Regional Econometric Model (REM). Some key datasets, such as the number of SMEs affected by a flood event, were not available from all of our LA partners. The results obtained (i.e., direct losses), along with the macroeconomic data, were then used in Module B, which includes an Input-Output model to calculate indirect losses to the regional or district economy. It calculates these costs over the time period of business disruption caused by the flood. Due to limiting factors that LAs may face when calculating the direct and indirect costs of flooding on SMEs (*e.g.* data availability, time, expertise) we developed two versions of TAEC: Module B.1 and Module B.2.

Module B.1 (Figure 10) is a variant of the Flood Footprint Model (Mendoza-Tinoco et al., 2017, 2020), which uses an Input-Output table (at the regional or district level) and

data gathered from the survey on the economic impact of a recent flood event (revenue, stocks and inventory losses, grants, insurance, repairs). The Flood Footprint Model found that the costs to the Yorkshire and Humber economy from the 2007 floods were 4% of the region's Gross Value Added (GVA), with 57% of the costs being indirect (Mendoza-Tinoco et al., 2017). The Flood Footprint Model was also used to assess the impact of the 2009 floods in Central Europe, and Mendoza-Tinoco et al. (2020) found that indirect losses account for 65% of the total costs. The model is run over a number of months, which is determined by the average time it took for business sales to return to normal (reported in the survey). This allows us to see what the initial impact of the flood event is, and compare this to recovery costs over the following months. The direct losses are calculated from the losses in Final Demand (FD) and the indirect losses are calculated from the losses in intermediate output.

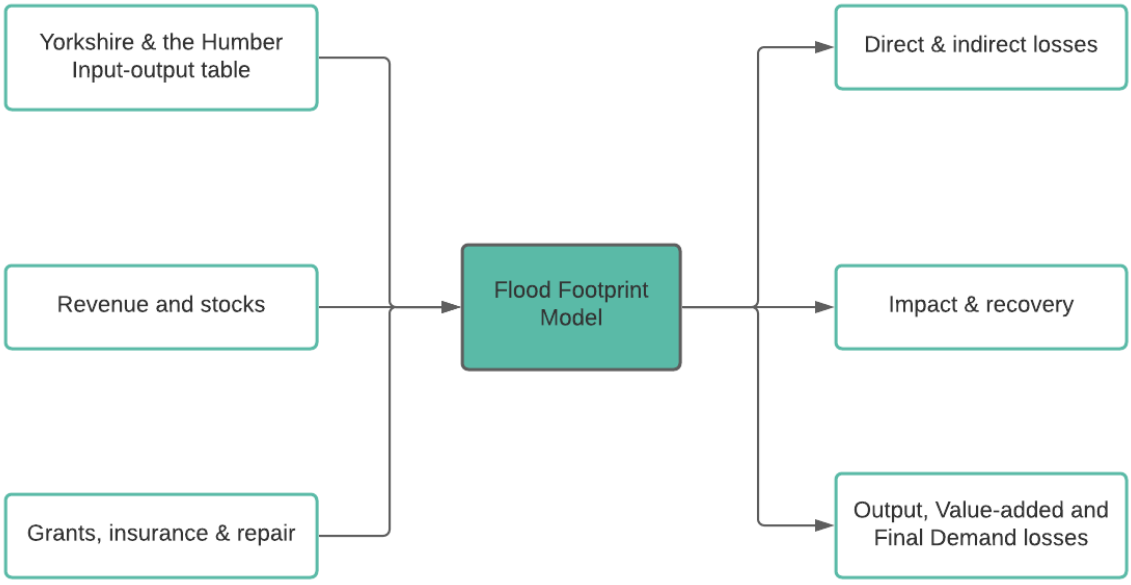

Figure 10. Inputs and outputs of TAEC.

The Module B.2 provides a simplified approach to quickly estimate the proportion of indirect costs faced by the regional economy that correspond to the direct financial costs faced by a representative SME according to the economic sector it belongs to. This approach is an alternative to running the full Flood Footprint Model and is not as comprehensive. Nonetheless, it is useful to obtain quick calculations. In basic terms, it comprises a table of sector specific indirect coefficients for each region in West

Yorkshire. As said, the coefficients can be used to produce a quick estimate of the indirect costs of one business or multiple businesses, using the known direct costs of a flood event. The indirect coefficients were produced using Input-Output tables calculated for each region following the method of (Hasegawa et al., 2009).

5.2 Development of tools: TAER

The LIS-B stakeholders were invited to contribute to the co-development of TAER at various stages throughout the process. Their insights and feedback were collected using the survey described in the last section, semi-structured interviews, and a focus group discussion.

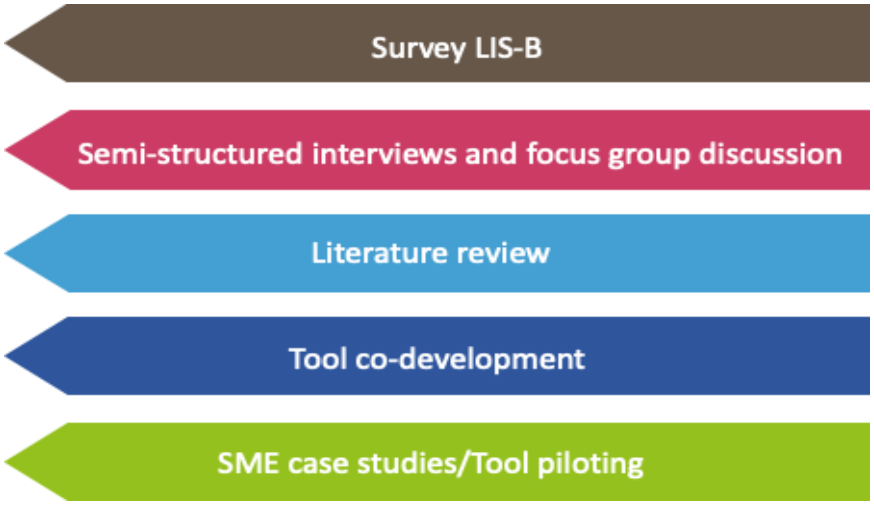

Figure 11. The development of the TAER followed these stages from top to bottom.

5.2.1 Interviews

A total of 18 semi-structured interviews with LIS-B stakeholders were conducted during September and October 2020 to assess their requirements for the resilience assessment tool. Each interview was scheduled for one hour via an online video conference platform (Zoom or Microsoft Teams) to abide by social distancing requirements. With participants' permission, the conversations were recorded and transcribed, coded and analysed using qualitative analysis software (NVivo).

The stakeholders interviewed agreed that a resilient SME should have some degree of understanding of their risks and a certain level of awareness of their flood resilience, which will give them a sense of control of their situation. It would be better if resilience is incorporated into the business culture. They also need to demonstrate that they

have the intention to manage their risks and have done as much as possible, given their abilities and capacity, to prepare themselves.

> *"I don't think they're ever going to be perfect, but I think wherever they're taking the opportunity to get the advice, implement the advice and maintain the systems are working, whatever that be, then I think that would demonstrate a resilient SME for me." (F3, Insurer)*

A resilient SME should also demonstrate the ability to recover quickly post-flooding, which means they should have some flood emergency response strategy and business continuity plan in place.

> *"So, a resilient business is one that can recover quickly, so in terms of flood resilience, we specifically refer to that as being in the internal protection measures, be that raised electrical sockets, raised electrical equipment, raised stock, they'd be flood resilience measures." (F11, Insurer)*

> *"Keep going in the fashion it would normally expect to regardless of the potential interruptions[...] resilience means being able to survive disaster and keep going." (F12, Lender)*

> *"Right, so to me resilience is if you flood on Friday, you're back in business on Monday." (F10, Broker)*

The interviewed stakeholders suggested that having PFR measures installed alone can no longer give them the confidence in an SME's ability to demonstrate their resilience. The participants revealed that in the past there have been cases where SMEs experienced relevant losses despite having some measures installed, which can be attributed to inappropriate products used, poor maintenance and testing, inadequate signposting and management, etc. In addition to the list of PFR measures used on the property, SMEs need to demonstrate that the measures are chosen and installed properly according to professional standards. Once installed, the flood

defence mechanisms should be subject to proper assessment and validation, and the SMEs should be able to provide a clear audit trail.

> *"(...) we've had a couple of very large losses where say flood barriers have been installed, but we've had losses. So, we need that confidence we've got someone competent who's assessed the whole building and then put in an appropriate package." (F11, Insurer claims)*

> *"Usually it's done on a very generic level, not on a specific level. I think that's what you guys are looking at, could you make it more specific, scientific, with a clear audit trail, which could give lenders more confidence." (F8, Lenders)*

Having a positive attitude towards risk that can be translated to positive behaviour is also very important. SMEs should provide evidence to show that they have put in serious efforts to maintain or increase their resilience. The evidence could be having clear documentation of testing and maintenance, implementing advice from professionals, or spending a certain amount on investing in resilience building.

> *"So, if you got a flood plan and it says to us that you are aware of the risk, and you are doing something positively trying to manage that. All that I have concern of that is there isn't an expectation of a reduction of premium just because of that, it's an attitude to risk and that's where it gets a bit intangible. But to me that would always show me that someone was on the case, understood the implications, and was working really hard to minimise that risk. That's all positive to an insurer." (F1, Insurer)*

A key message that came out of the interviews is the urgent need to make changes to the status quo, as the flood map that insurance companies use cannot give them more minute and specific information beyond the postcode. With climate change causing more frequent and extreme flooding to happen, this means that more SMEs will become uninsurable.

To make changes and drive the societal shift: *"the tool can help make the conversation so much more beneficial for everyone" (F1, Insurer)*

The tool can help make SMEs information more accessible to insurers. *"Any sort of information that you have that can tell your story is more convincing then to the insurer" (F2, Broker)*

Interviews revealed that the tool would facilitate communication between SMEs and insurers, and drive behavioural change in both parties. For example, insurers believe that the more detailed SMEs describe each step they take, the more confidence they have in SMEs' ability to understand their own risks. By going through the self-evaluation, SMEs would have the opportunity to become more resilient by using the trusted sources of information, and links to learning materials. The tool can help the insurers and the businesses to be more proactive. It was stated that the status quo is reactive, thus capturing data in advance to minimise future risks in the tool would be ideal.

It encourages people to consider their risks more, and know that "if you ask these questions about our business or if you can't answer them then these are the people you need to speak to" (F3, Insurer)

It helps people understand "what information the insure is going to look at to change their mind about [insurance coverage]" (F1, Insurer)

The SMEs should be made aware that each SME is unique and underwriters look at each case on its own. This means that the more details an SME provides, the better the underwriters can accurately assess its risks.

The tool can be a "living tool", like a record of what happened at that property... Like a V55 form for cars (F2, Broker).

Meanwhile, the brokers and insurers we interviewed also hoped that the tool can facilitate communication and knowledge transfer between brokers and insurers, and between insurers and lenders.

> *"Where the broker can have a bigger influence really is if they know more information about that client. So, you know, they will have information or know the client that makes it a slightly different risk and, you know, in flood terms, it might be that they know that area of the town has never flooded. So, there's an additional, sort of, overlay of information that a broker will give to an insurer, and that can make a difference." (F2, Broker).*

> *"Creating real conversations with lenders and insurers beyond the map, and providing better evidence to impact their decisions. Having a standardised way to capture information" (P1, Insurer).*

5.2.2 LIS-B focus group

An online focus group with 5 representatives of insurers, surveyors, brokers and lenders was held to critique the structure, function, and features of the tool, based on the data gathered through interviews with LIS-B stakeholders. Figure 12 is the working model of the tool that was presented at the focus group discussion. It outlines the main goals of TAER, and what each Module entails. At this stage, Module A is intended to be used by surveyors to perform flood hazard assessment and property level resilience assessment. Module B is intended to be used by SMEs to conduct a self-assessment on their resilience. Module C is for results reporting and data sharing. During the focus group discussion, we asked the participants to comment on three areas – data and evidence collection; reporting and evaluation; and distribution and development.

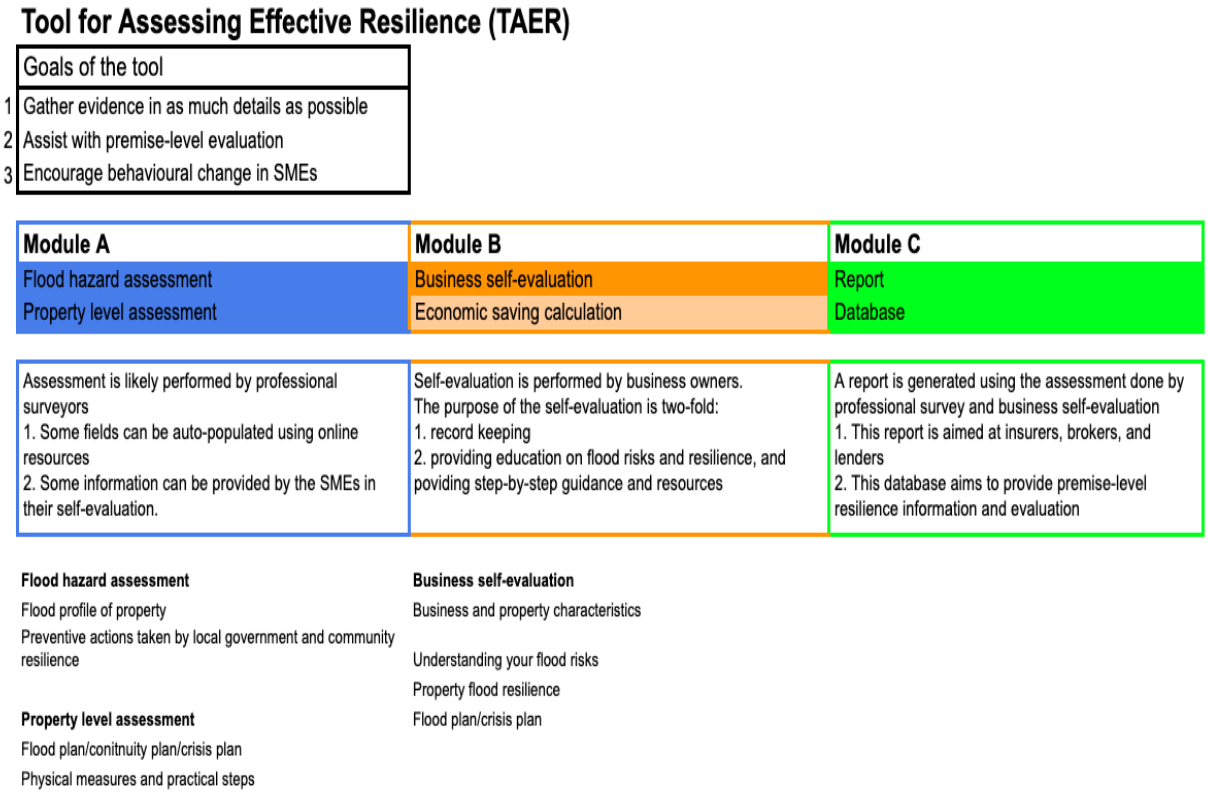

Figure 12. Mapping of TAER modules.

Data and evidence collection:

The participants commented on several areas regarding the data and evidence collection. First of all, while a well-informed SME owner/property owner can capture detailed business-related information and straightforward flood risk and resilience information, the flood risk assessment and the on-site survey of building resilience should be carried out by professional surveyors.

"I'm thinking that you would need a surveyor to validate what the current situation was or the measures that had been put in"

"From our point of view, that property level resilience with temporary measures shows the benefit of having this as part of your mind-set that you need to do a property level assessment, but it would have to be on the back of something provided by a surveyor with that sort of credibility behind it.

In addition to asking about whether certain PFR measures are installed or whether there is a business continuity plan or flood plan, SMEs should upload documents, photographs, videos, and narratives of examples as supporting evidence. It is also important that the tool asks whether SME has been flooded before, how they were impacts, and how they recovered.

> *"It would really just be the story of what they've done to the property; I wouldn't necessarily think it would be a full business continuity plan, so for me it would be a document where they've gone through the process of seeing everything they've done[.]"*

We also learned that the information should be credible, and one way to guarantee that is to show evidence of the quality of the PFR measures and the competency of the product installer and surveyor.

> *"I would like to know what they've done, who they've engaged to do it, and their credibility, as in what are their external certificates that allow them to do that... there's some sort of guarantee of the person's competency to do the work... And that's the sort of thing an insurer would want to know, that it's not just any product, it's one with some degree of external validation."*

Finally, it is important for an SME that is leasing their business property to communicate and work with the landlord, and achieve a partnership between them.

> *"Roughly half of the commercial buildings in the UK are owned by a landlord who missed out to a tenant who runs a business, so you've got a very natural split incentive right from the start. What you guys have to get around is there's a way for the tenant who runs the business and the building owner who is responsible for some of the risk and the value attached to it to be able to exchange the right data and information."*

5.2.2.1 Reporting and evaluation:

The presentation of the data should help insurers and brokers better understand SMEs' behaviour. It is suitable to present a list of information about the building, its resilience, the business continuity plan, as well as supporting evidence, such as photographs, videos, narratives, and documents. It is also important for the insurers to be able to focus on the data that are most relevant to their decision-making.

"The first one is definitely the strength in collating the information in the one place."

"If it was a list of almost table of contents for that building with the availability of the data for each of the elements."

"Assuming it had been flooded or at risk, [brokers are] going to want to look at a document, and I think the point that was just made is right, that looks really, like I understand this is about this building and they've analysed it properly, so I can see they've considered all the factors and they've made recommendations or whatever it is. So, it's not: I've got 16 pages of computer type, and I don't know what to look at, so I'm just not going to bother."

In terms of having a rating system, the consensus was that it would be valuable to the SMEs to have a way to compare to similar businesses in the local area or national average in order to gauge their performance.

"People like to see how their own business and/or building looks compared to others in the local area, or I guess the national average or some form of benchmarking or metric that kind of gives them some value to it."

On the topic of creating and maintaining a database, we realised that it would be very difficult to achieve at the moment and it can be quite complicated to navigate between the costs and ownership of the different sources of data.

"It's almost stages. So I'm thinking that the first stage is to get the A, B & C bit of it right; now the worst case is out of all that comes a report in a format that people can access, the format of it, so you're not storing the data, and that is provided to insurers to augment their existing, or lenders, their existing information, now that would be a massive step forward."

5.2.2.2 Distribution and development:

The participants also discussed how the tool can attract more buy-ins from both SMEs and LIS-B stakeholders and provided recommendations on further development. To increase the success with LIS-B stakeholders, it was suggested that the tool should be able to provide a feedback loop between SMEs and LIS-B stakeholders.

"What I've always thought this can really do is have that feedback loop in it somewhere, so that when you get an event you see how well you've managed, you fix up things that didn't work and then you have something to show the insurance too to say, 'Look. We are really actively involved in this and we have found where we weren't as robust."

Based on the discussion, we recognised that more learning elements for the SMEs are needed. It is important to not only provide instructional information on the measures and strategies one should implement, but also contextual information that makes it easier for the SMEs to understand why certain questions are asked or certain steps they should take for flood resilience.

"[Y]ou really need to make sure you get the right advice on this; understand what you know and you don't know and then get the advice for the things you need help with and I think that is really key[.]"

5.2.3 Prototype building

Based on the interview findings, the tool should aim to achieve three goals:

1. Gather evidence in as much detail as possible to aid decision making on offering flood insurance coverage to SMEs.
2. Assist with the evaluation of resilience at the premise-level.
3. Educate SMEs about their flood risks and encourage behavioural change.

By incorporating the critiques and suggestions from the focus group, the tool evolves to contain one module for SMEs learning purposes, and two modules to capture an SME's resilience level from both perspectives of professional surveyors and the SME owner or representative. As presented in Figure 13, the tool at this stage contains three modules: The Module I (Learning Suite) and the Module II (Self-assessment and record-keeping) are used by SMEs, and Module III (Professional flood risk assessment) is used by surveyors. Module II and III will help facilitate the insurers and underwriters' decision-making process. Together with Module I and collaborator contributions on products and personnel credibility, they form a feedback loop between the SMEs and LIS-B stakeholders, especially the insurers and brokers.

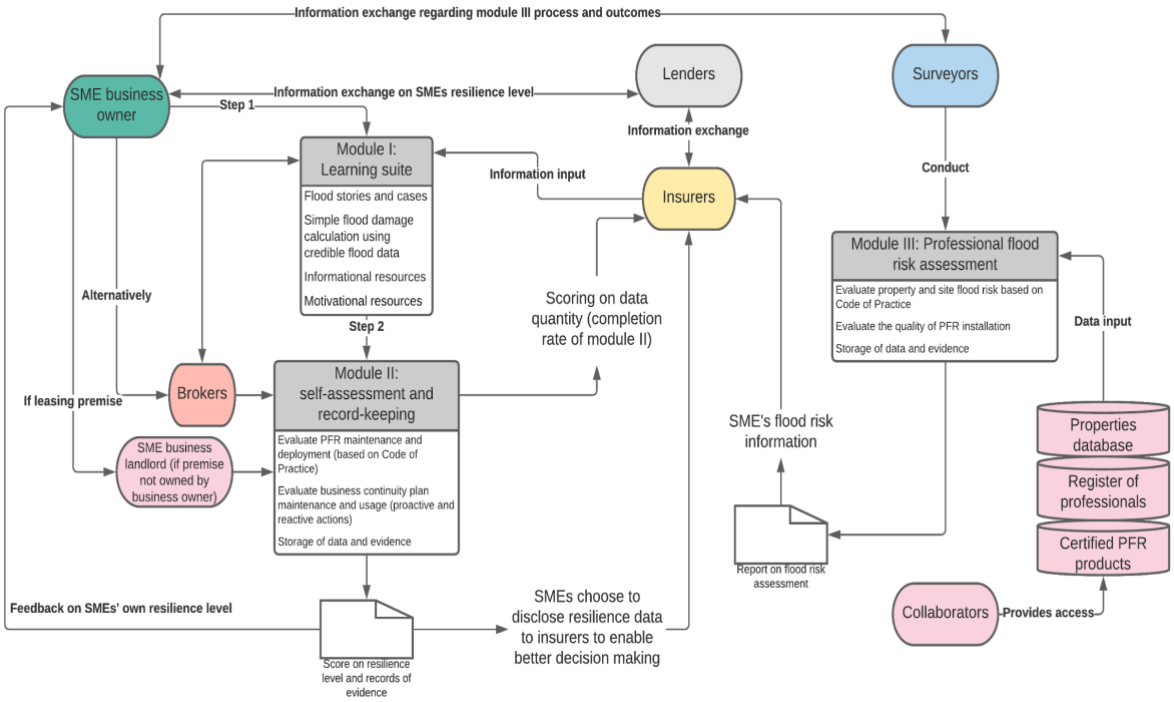

Figure 13. Mapping of TAER presented at the focus group, consisting of the three modules and the feedback loop between the stakeholders and SMEs.

5.2.4 Pre-piloting TAER

Before piloting the tool, we decided to test it with several SMEs to further tailor the content and format to their preferences and needs. From the TAEC survey, a list of

SMEs that were interested in participating in further research was compiled. We wanted to have the greatest representation of SMEs, so we then narrowed the list down based on: their perception of flood risk, their geographical location, their sectors, their past experience with flood insurance (if they didn't have access to insurance, or if the quotes/premiums were very hight), their size, age, flood experience, flood preparedness levels and on whether they were renting/owning their premises.

We selected several SMEs from this list and sent them both Module I and Module II, and then took their feedback via interviews. After we incorporated their feedback to improve modules I and II, 6 case studies were selected based on the criteria mentioned before.

Module III also went through a refinement process with 4 professional surveyors providing feedback to improve it.

5.2.5 Piloting TAER

The 6 SMEs were given access to **Module I** to update their knowledge. This module takes shape in a website. It contains the general information regarding flooding and the impact of climate change. It also serves as a hub of resources on flood preparedness and property flood resilience. More importantly, this module is a key component of the feedback loop between the LIS-B stakeholders and the SMEs.

Module I: Learning Suite	Flood risk and climate change
	Insurers' messages
	SMEs flood resilience toolkit Preparation and response to flooding (flood kit, flood plan, etc.) Property flood resilience measures and strategies
	Flood stories
	Additional resources Yorkshire and Humber councils provided information Code of Practice

Then, the 6 SMEs used **Module II** to perform a self-assessment of the business's flood resilience. The SMEs are asked to document and describe their actions on flood

planning and property flood resilience. Module II goes through a detailed business continuity plan. Important is to mention that the content and questions in this Module were gathered from intelligence of previous studies and a revision of the literature. Another set of information included in the pilot is the SMEs' past experiences with flooding, their economic damages and recovery process. In this case, we pulled the information from the results of **TAEC Module A** such as experience with flooding, damages, recovery, flood protection.

Module II: SME self-assessment and record-keeping	Building information
	Flood risk information
	Flood planning provide document and record of testing and maintaining when possible
	Action plan when flooding is imminent
	Property Flood Resilience measures: provide photographic or video evidence of the measures provide record of testing and maintenance explain why and how the measures are installed and implemented
	Outputs from TAEC Module A

Module III is the professional survey, and surveyors from Sedgwick were involved in the data collection using this Module. First, for each SME they performed a desk-based revision of the site, and used a flood-risk and hazards assessment model report provided by Ambiental. Then, they used Module III to conduct the on-site surveys.

Module III: Building resilience survey and flood risk assessment	Building resilience and hazard assessment Hazard assessment Pluvial screening for surface water flooding Fluvial screening for river flooding Tidal screening for storm surge flooding Property performance and flood resilience Flood emergency plan and business continuity plan

6 Results of piloting the tools

6.1 TAEC

The first step in piloting the tool was to survey SMEs regarding the impact of flood events on their businesses. We surveyed 135 SMEs, with 126 of these located in 15 districts across Yorkshire and the Humber. The survey was conducted in the Autumn of 2020 and the SMEs surveyed belonged to 17 different sectors (See Figure 14).

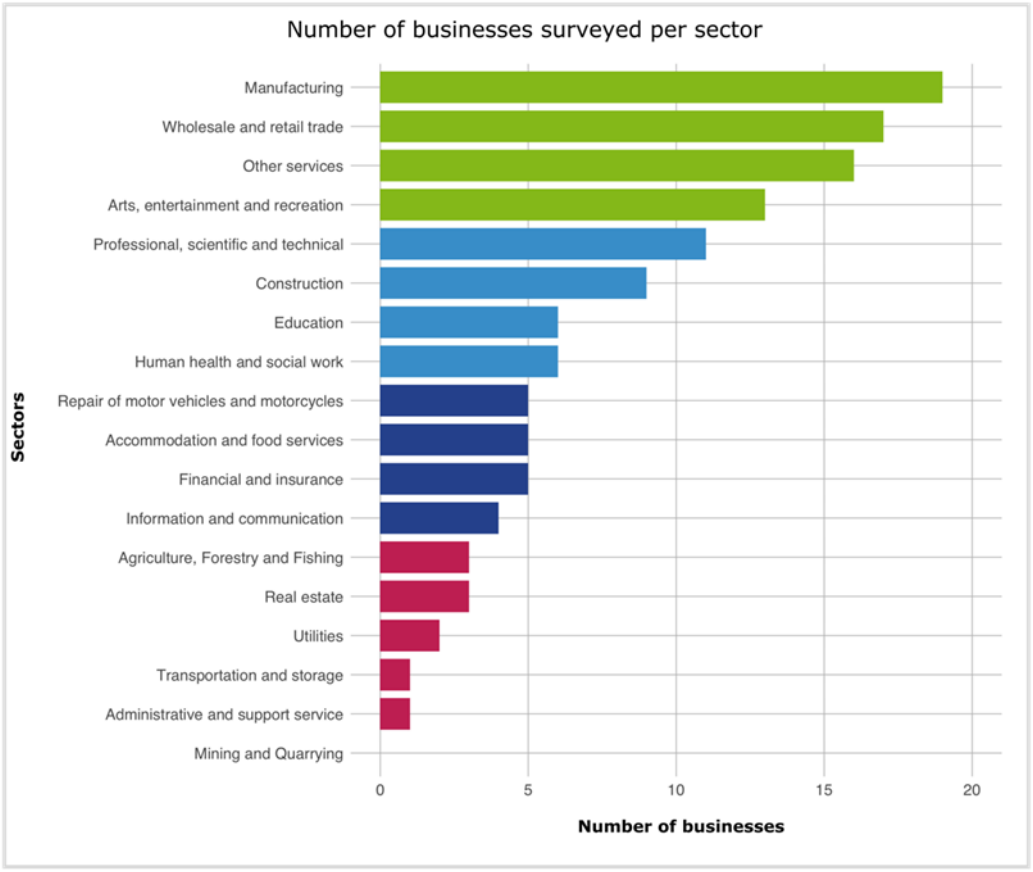

Figure 14. The number of businesses surveyed by sector.

Most of the surveyed SMEs (72.4% N= 127) have been affected (directly or indirectly) by flood incidents in the past. On average they have been affected 4 times by all kinds of flooding. The type of flooding mostly experienced was river flooding (72%, N= 56), followed by groundwater flooding, flash flooding and finally sewerage flooding as can be seen in Figure 15. The year when they were most impacted was 2019 (N=33), followed by 2015 (N=31). The businesses reported the years when they experienced the worst flood event, and 53.2% of these incidents have been in the last 6 years

(N=67); and the year when the business experienced the worst flood incident was 2015 (N=25).

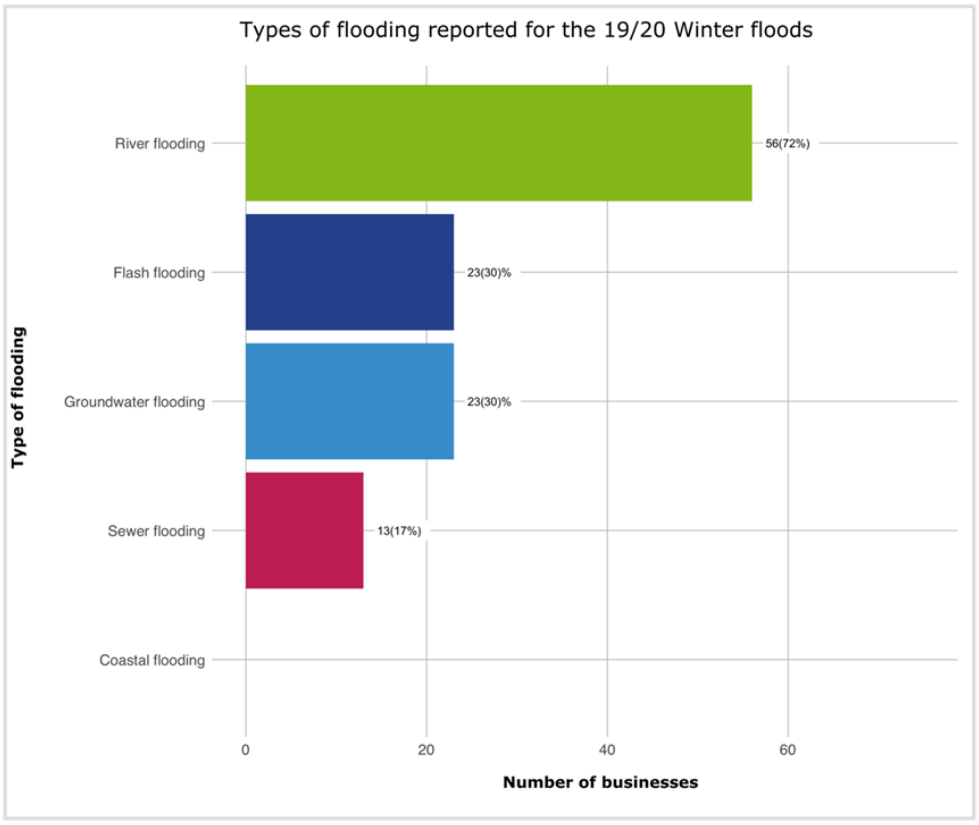

Figure 15. Type of flooding experienced in Yorkshire and the Humber 2019/2020 winter floods.

The 2019/2020 Winter floods caused the average losses presented in Table 3 below according to business size. Whilst the businesses with 20 or more employees suffered the largest losses, when compared to the average monthly turnover, it can be seen that the smallest SMEs (0-4 employees) have average losses that are greater than their monthly turnover.

Table 3. Average losses reported by SMEs in Yorkshire and the Humber for the 2019/2020 winter floods, categorised by business size (number of employees).

Number of employees	Average monthly turnover	Average losses
0-4 (N=54)	£8,724	£9,825
5-9 (N=32)	£99,410	£46,064
10-19 (N=12)	£98,507	£19,422
20 or more (N=28)	£384,772	£93,577

6.1.1 Damages and costs

We calculated direct financial losses (direct losses faced by firms) and indirect economic losses (faced by regional or district economy). These are reported in the Direct losses and Indirect losses sections below.

6.1.1.1 Direct losses

62% of the companies surveyed were affected by the 2019/20 Winter floods. The average inundation depth they experienced with this event is 1.8 m (trimmed mean =1.4 m). The most common types of damages they experienced were related to access due to disruptions in roads, motorways, etc. (68%), followed by temporary closure of premises (56%). The other impacts can be seen in Figure 16.

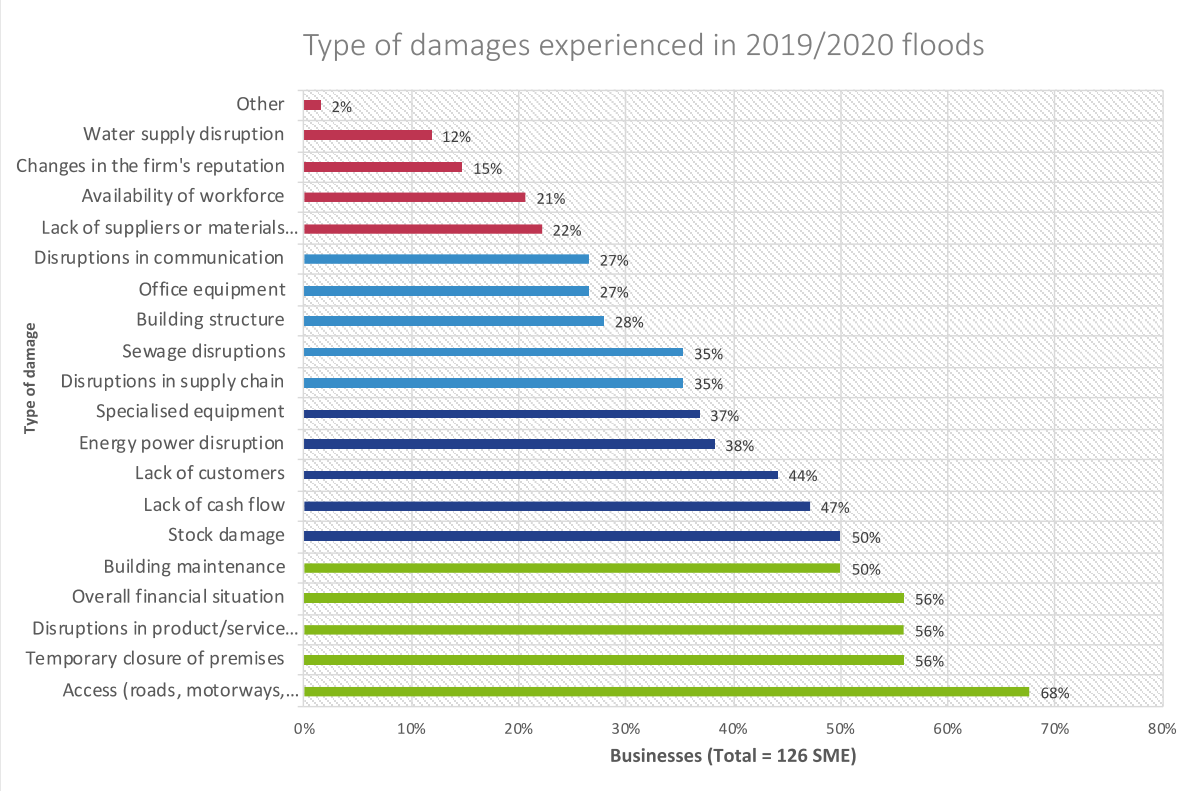

Figure 16. Types of damages experienced by SMEs in Yorkshire and Humber 2019/2020 floods.

Multi answer: Percentage of respondents who selected each answer option (e.g., 100% indicates that all respondents selected the same option in this question.

We looked at the top 4 types of damages for each business size, in terms of the average cost (Figure 17). The smallest and largest businesses (0-4 and >19 employees) both reported the biggest losses in equipment, and this was the second biggest loss for businesses with 10-19 employees and the fourth highest of businesses from 5-9

employees. The largest businesses had high losses (10-19 and >19 employees) in vehicles, and they also suffered greater average losses in business interruption costs when compared to the smallest businesses (0-4 employees).

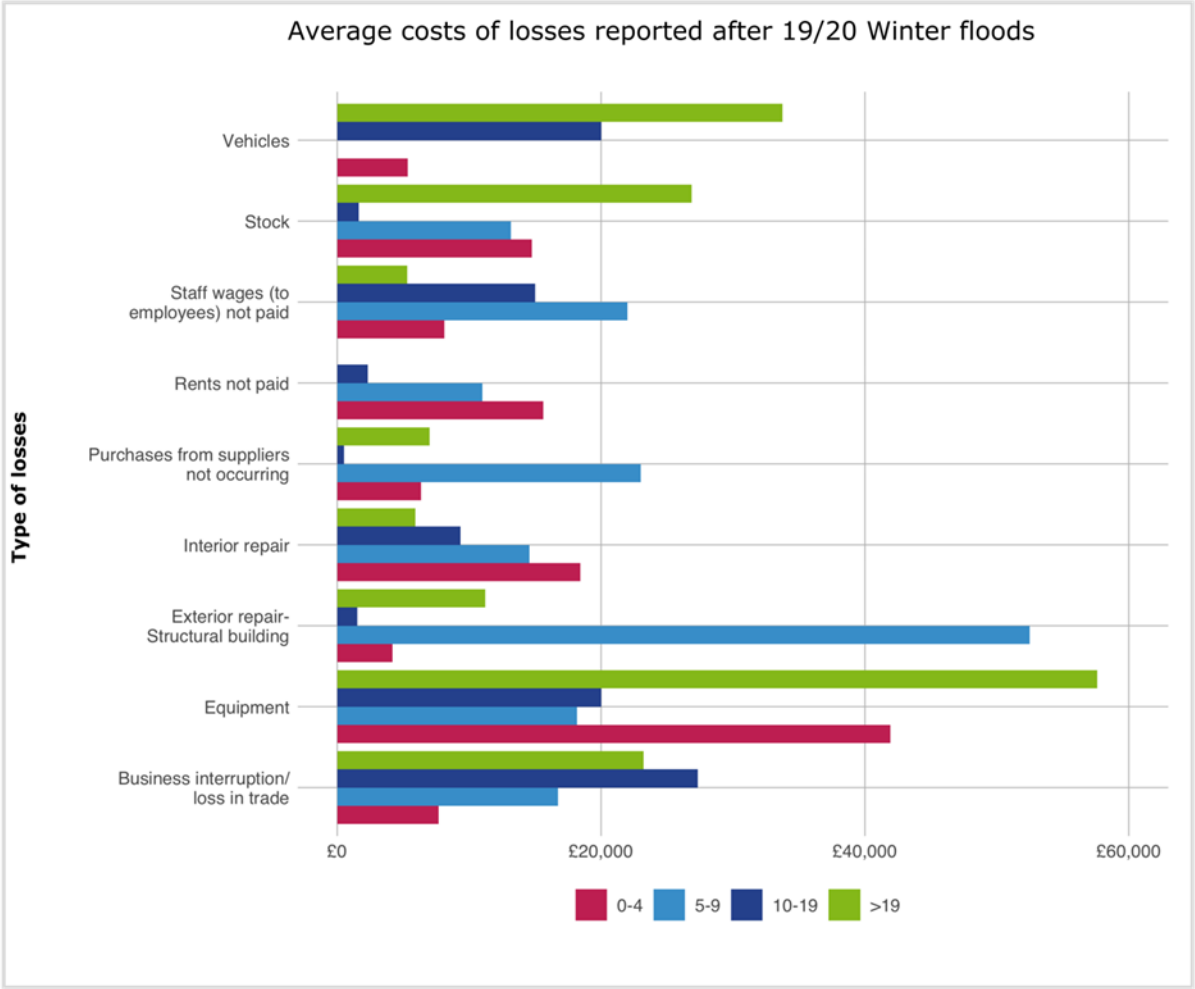

Figure 17. Average losses incurred by SMEs in the 2019/2020 winter floods for Yorkshire and the Humber, according to business size. These categories are a subset of the survey and were chosen because they have the largest losses (top 4 for each business size).

In terms of the direct losses, the larger the business, the larger the average loss in revenue from the 2019/2020 winter floods. However, when we also take into consideration the average monthly turnover it becomes clear that the smaller businesses suffer the most losses in relative terms (Table 3 and Table 4). The losses represented 113% of their monthly sales, which means that they would need to save their entire monthly revenue to be able to recover what they lost. This same pattern was found by Sakai et al. (2016) for the 2015 Boxing Day floods in Calderdale, and also reported in Sakai (2020). When comparing both survey results from Calderdale, for both the 2015 and 2019/2020 events, the smaller businesses suffered the greater losses

(Table 4). An important difference is that the direct economic losses were greater in 2015 due to the larger magnitude of the event.

Table 4. Direct financial losses (% of monthly turnover).

Number of employees	**2020** survey results: **Y&H 19/20** flood event	**2016** survey results: **Calderdale 2015** Boxing Day flood event
0-4	113%	271%
5-9	46%	20%
10-19	20%	61%
>19	24%	75%

6.1.1.2 Indirect losses

In terms of the indirect losses, we ran Module B.1 for the 2019/2020 winter floods in Calderdale and the results are reported in Table 5. The results from Module B.2 (the indirect coefficients) are reported in the appendix. The indirect ratio was 63.4%; that is, for every £1 of direct losses, there was a further £0.63 of indirect losses. This is very similar to the results of Sakai et al. (2016), who found an indirect ratio of 62% when assessing the impact of the 2015 Boxing Day flood in Calderdale. Our results show that, just in Calderdale, during the winter of 2019/2020 the floods caused £43.3 million in direct losses, with an estimated £25.1m in indirect losses. The total losses in 2015 Boxing Day were higher[2], because of the greater magnitude of the flood incident in terms of river levels. For example, the River Calder in Todmorden peaked at 1.76 mALD on 16/03/19 and at 2.77 mALD on 26/12/2015 (Calderdale Metropolitan Borough Council, 2019). Interestingly, the amount of rainfall recorded in the 15 days prior to both events was similar; e.g., Gorpley reservoir recorded 202.8 mm and 198.2 mm antecedent rainfall for 16/03/19 and 26/12/2015 respectively (Calderdale Metropolitan Borough Council, 2019).

[2] It should be noted that the modelling conducted in Sakai et al. (2016) to determine the indirect costs for Calderdale during the 2015 Boxing Day floods did not include an estimation of costs related to the average recovery period. The loses that occurred immediately after the impact should be used to compare results from both studies.

Table 5. Direct and indirect losses from the 2019/2020 winter floods in Calderdale. This is the output from Module B.1, the flood footprint model.

	% Final Demand (monthly) lost	Direct costs £mil (value added)	Total output £mil (monthly)	Indirect ratio
Impact month 1	7.2%	18.2	28.7	63.4%
Recovery month 1	4.6%	11.3	17.7	
Recovery month 2	3.7%	9.3	14.6	
Recovery month 3	1.9%	4.6	7.3	
Recovery month 4	0.0%	0.0	0.0	
Total	40.9%	43.3	68.4	

6.1.2 Recovery

The 2019/20 Winter floods brought closure of premises which were on average 13 days in the first month after the impact. Most of the businesses lost 31% of their monthly sales (See Figure 18). The number of employees laid-off as a result of the 2019/20 flood incident was 57.

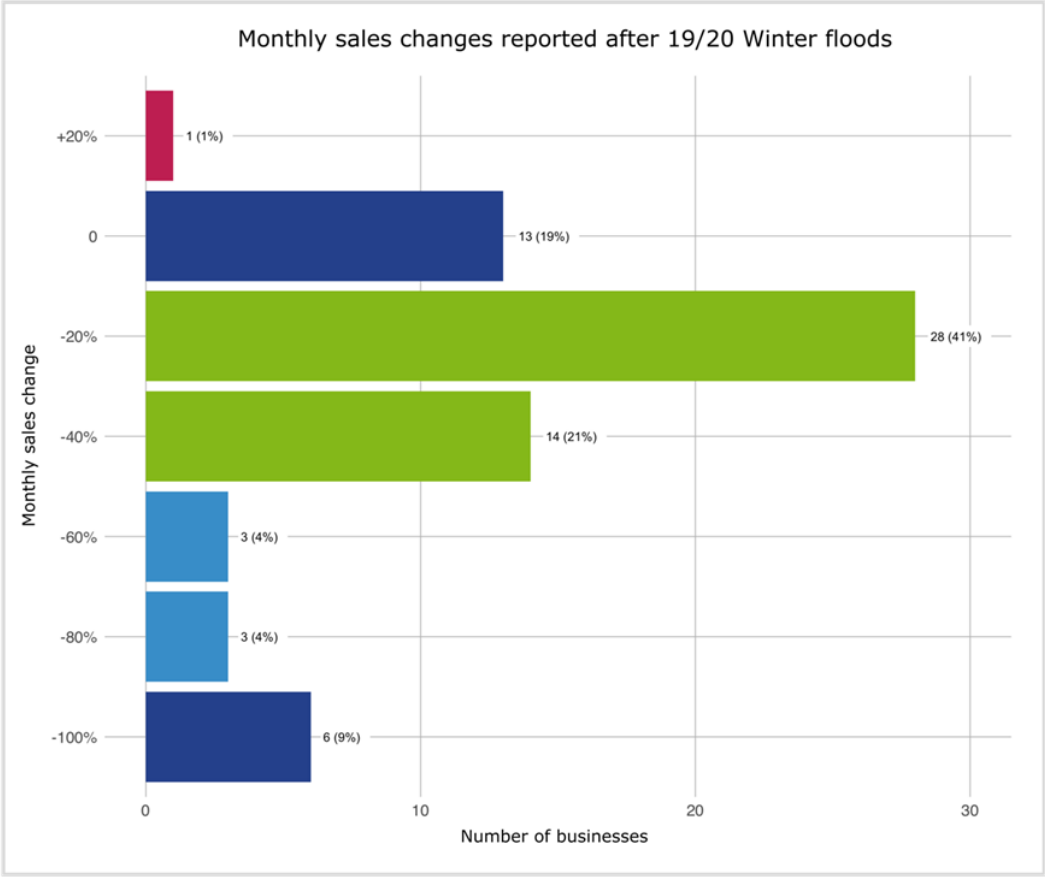

Figure 18. Monthly sales changes reported by SMEs in Yorkshire and the Humber for the 2019/2020 winter floods

Previous research has shown that SMEs look for external support when experiencing a flood incident. The most common support they receive is grant aid from local or central government (N=20, 15.87%), followed by advice from the council (N=15, 11.9%), a business rate rebate (N=7, 6.35%), and other meaningful support (N=8, 12.7%). 26.20% (N=33) of the SMEs responded that they did not need external support as they used their own savings. Businesses reported that the most useful type of support before an imminent flood incident is grant aid from local or central government (N=19), followed by advice from the council, then from business support organisations, business rate rebate, credit from supplier, crowdfunding or charitable donations, and loans from bank. During and after a flood incident, it is advice from a business support organisation (N=7; N=8, respectively). Additional things that were reported as useful: flood resilience measures, help from the Environment Agency before a flood, help from customers during a flood, and mental and moral support from the community. The essential things that you need to continue operating after a flood by size are determination (0-4), power, computing, internet, data management (5-9), premises,

manpower and financial assistance (10-19), and power, computing, internet, data management (>19).

6.1.3 Insurance

38.9% (N=35) of the businesses that answered the questions (N=90) have insurance (Figure 19). Of those that do not have insurance, 47% (N=49) reported that they could not get insurance because: 'it isn't worthwhile' (41%), could not get a quote at all (39%), the quote was not affordable (12%) reporting an average of unaffordability of £5,932; 'I don't have time or don't know how to get a quote' (2%), other (6%). They were asked if they had issues with insurance and they said: "*Don't trust insurers to pay-out*" and "*Now they won't even quote when the postcode is given, as we are now classified as on a flood plain*". They were asked how much money they were willing to pay per month to have flood insurance, and the average is £218. The smallest businesses (0-4) on average were willing to pay £127 (std. dev £371.2). Businesses of sizes 5-9 on average were willing to pay £110 (std. dev £159), and larger SMEs (>19) on average were willing to pay £669 (std. dev £953).

Over half of the SMEs (N=66, 52.4%) reported to have any issue with insurance. SMEs reported having issues regarding insurance in terms of high premiums (59.1%), high excess (47%), difficulties to make an insurance claim (27.3%), flood prevention measures not considered on the pricing (31.8%), amount of time it took the insurance company to pay (16.7%), and unsuccessful claim (9.1%). Other issues mentioned are "*No info on what to do regarding floods, etc. It made us feel like insurance was trying to push us away*". 46.8% (N=37) of the SMEs found that the costs of having insurance outweigh the benefits. Interestingly, those businesses that think that the benefits outweigh the costs were willing to pay more than the average.

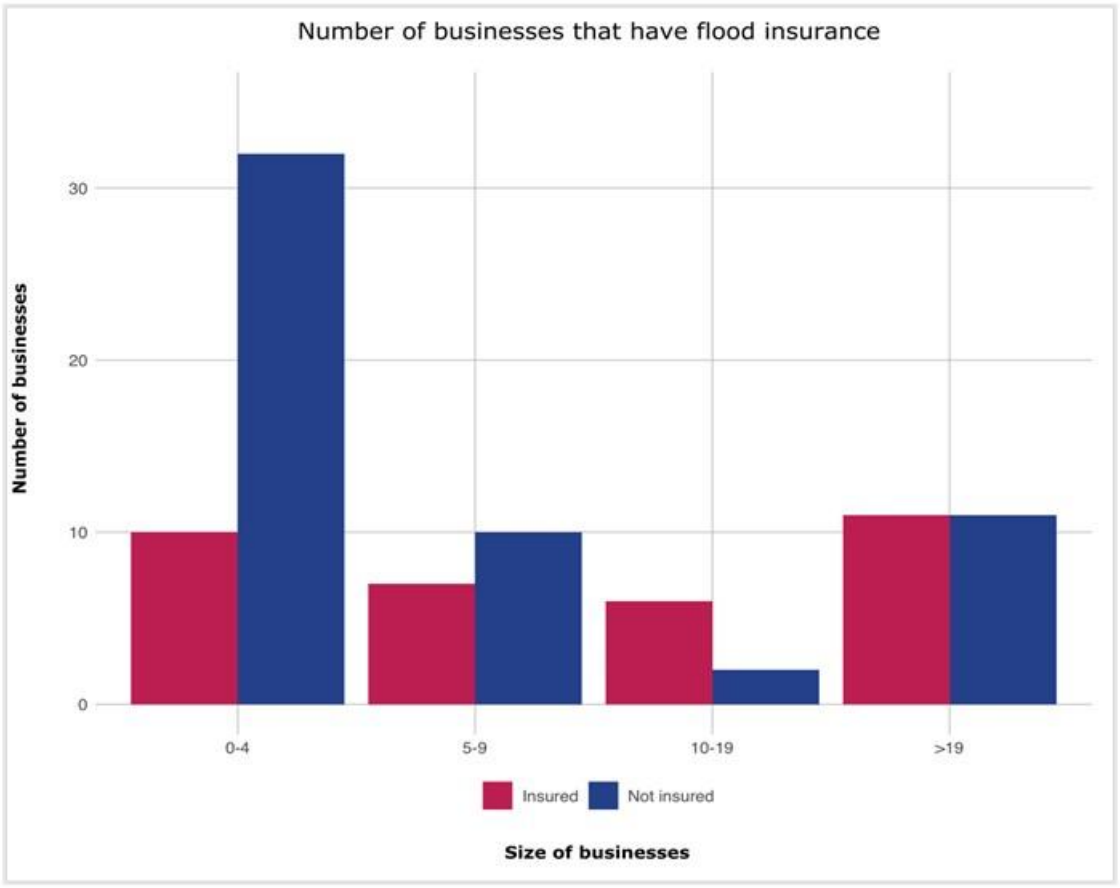

Figure 19. Number of businesses that are insured or not, by business size.

6.1.4 Flood preparedness: reactive and proactive

For adaptation to take place, there is a need to be aware of the risk and that you can do something about it. In our sample, 39% of the businesses perceive they are at higher risk of going out of business because of the impact of a flood. 68% (N=92) of the businesses were confident of having reconstructed their business after a flood event in a way that is now better equipped to face another flooding event of similar magnitude.

A flood incident requires SMEs to take steps before, during and after the flood. The imminent impact requires strategies that will help them to cope better with the event. 78% (N=64) of businesses reported that they would sign up/monitor Environment Agency (EA) flood warnings (Figure 20). Of the businesses that reported signing up/monitoring Environment Agency (EA) flood warnings, the majority (42.2%) were the smallest businesses (0-4 employees).

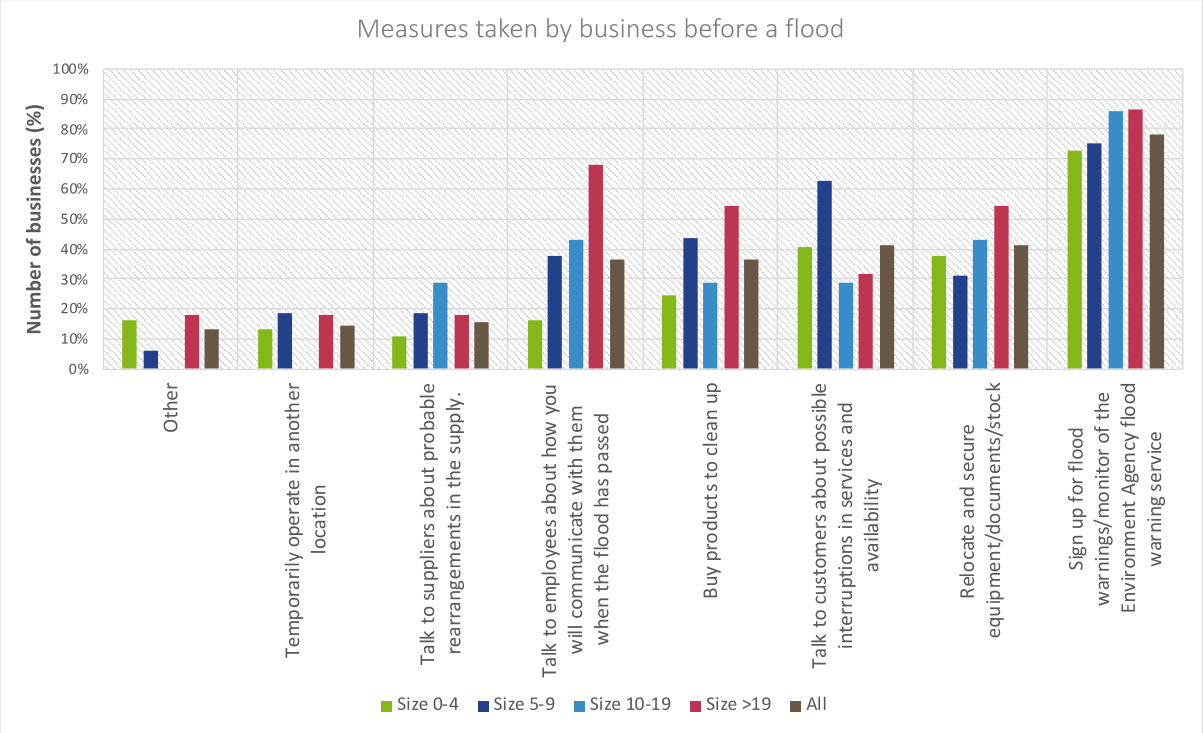

Figure 20. Measures taken by businesses before a flood, by business size.

After the flood water recedes and things get back to being more normal, businesses have the opportunity to learn from the event, be proactive and develop strategies to be better prepared for the next event. The majority of businesses reported that they developed a flood plan (69.1%), but only 30.9% regularly updated the flood plan, and 36.8% developed a business continuity plan. When we look at the results by size of business, we can see that the smallest and largest businesses are slightly more likely to have developed a flood plan (0-4, 74% and >19, 84% vs 5-9, 53% and 10-19, 43%), and the smallest businesses were the least likely to have bought flood insurance (0-4, 15% vs All 25%) (Figure 21).

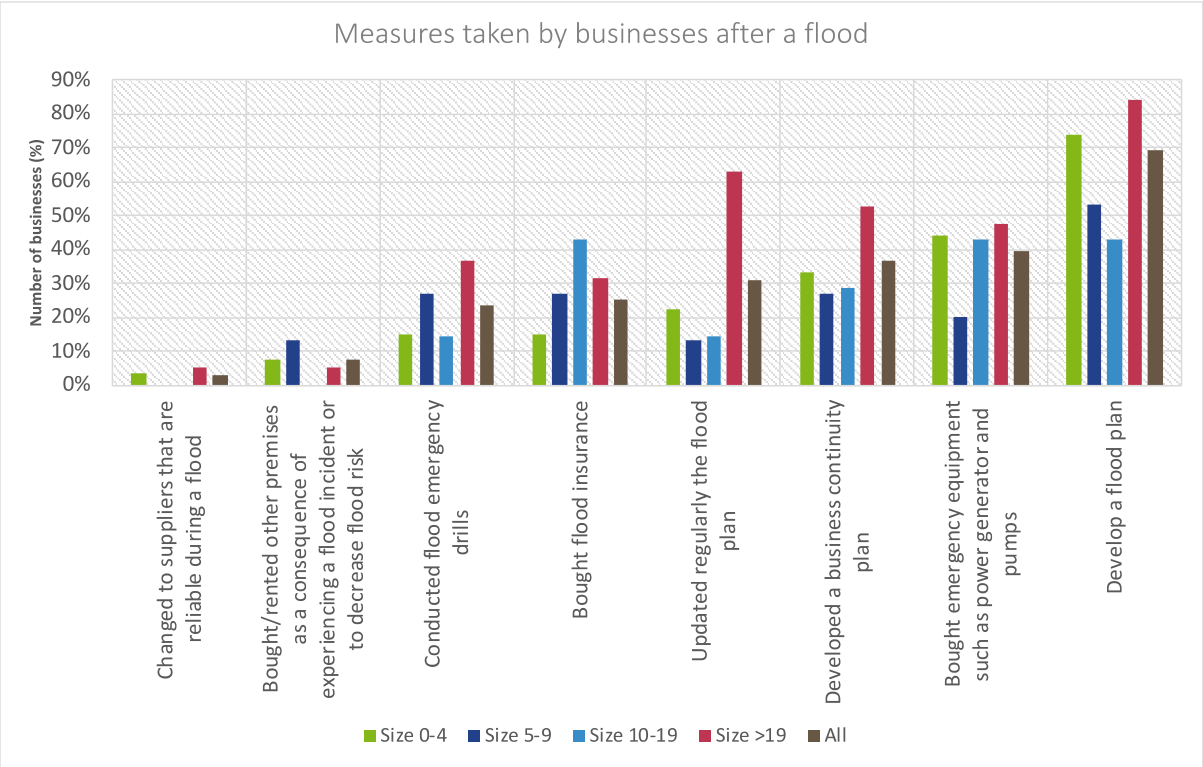

Figure 21. Measures taken by businesses after a flood to minimise the impact of future flood events, by business size.

To better prepare their businesses, 44.4% (N=56) adopted at least one PFR-recoverability measure. Among these SMEs, 60.7% (N=34) have raised their power sockets, and 51.8% (N=29) have implemented resilient floor finishes (Figure 22). 43.7% (N=55) SMEs adopted at least one PFR-resistance measures, among which 54.5% (N=30) of businesses reported that they had temporary barriers and 9.1% (N=5) had permanent barrier. The next most adopted resistance measure was blockage and coverage of pipes, holes, etc., which was reported by 36.4% (N=20) businesses (Figure 23).

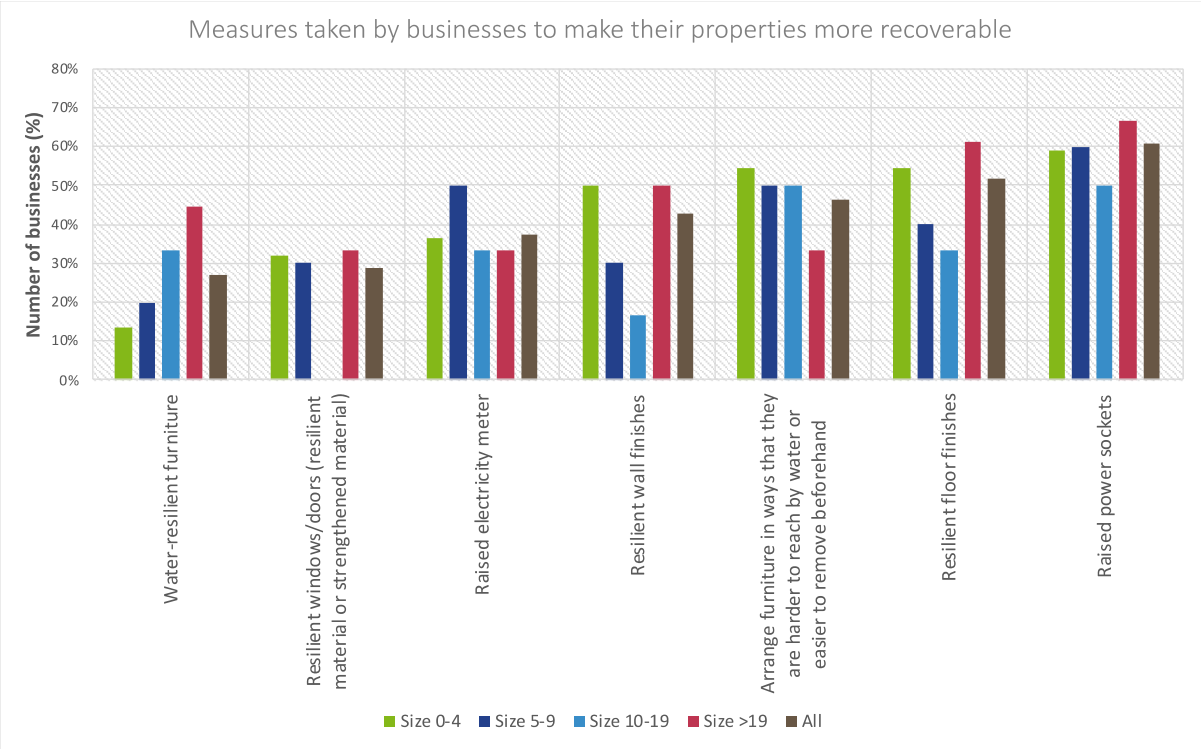

Figure 22. Measures after a flood to make business's property more recoverable, by business size.

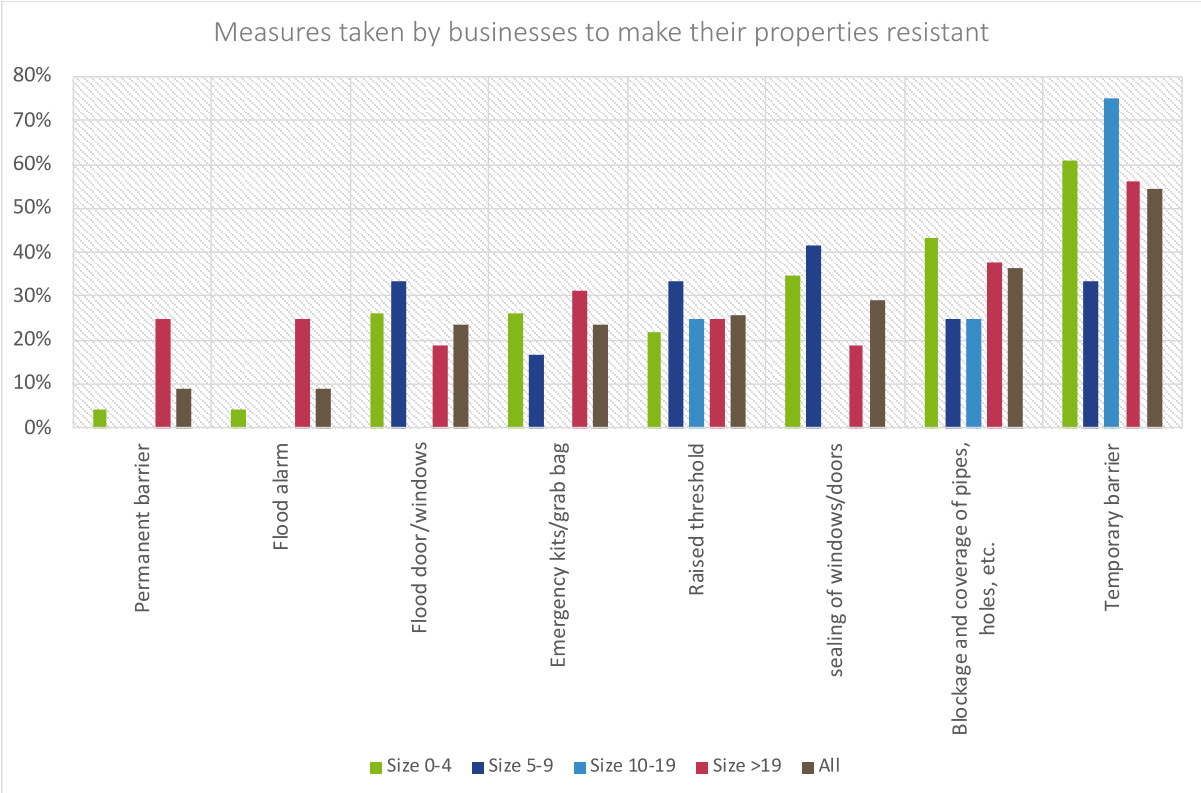

Figure 23. Measures taken after a flood to make business's property more resistant, by business size.

64.3% (N=81) businesses responded to the question how they would like to receive flood advice in order to be better prepared in the future. Among these businesses, 30.9% (N=25) preferred to receive professional advice, 23.5% (N=19) would like to use online training and offline resources. However, 44.4% (N=36) expressed that they did not need any flood advice, and the smallest businesses were more likely to believe they did not need more flood advice (0-4, 53% vs. All, 44%) (Figure 24).

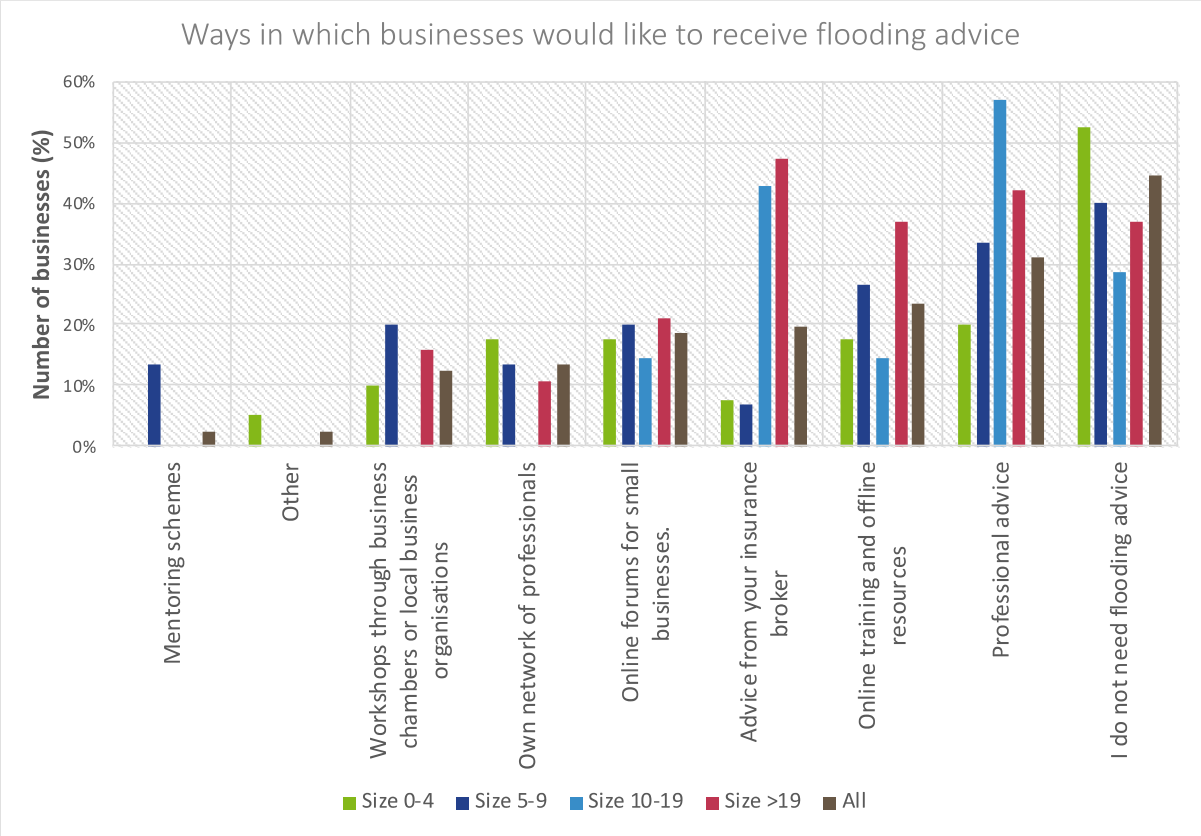

Figure 24. The ways in which businesses would most like to receive flooding advice, by business size.

6.1.5 Improvements when owning or renting premises

Most businesses have just one premise that are part of their business (71% N=65), and for the majority, their only premise is not home-based (78%, N=72). Just over half of the businesses own their own premises (53%, N=49), and around half of them (N=24) have made improvements to the property to prevent future flooding after the impacts of recent flood incidents. 47%of the businesses are tenants (47%, N=43) and 40% did not know if their landlord had flood insurance for the property and the majority (74%, N=32) thought landlords should disclose this information to all tenants. 58% (N=25) of

tenants reported that landlords had not made improvements to prevent flooding on their properties, which could have negative consequences for businesses. Businesses who are renting their premises are keen to implement improvements to prevent future flooding with 54% (N=21) saying they would have done the improvements (as they would have been cheaper than being flooded). 13 of those businesses (41%) would have done the improvements but they might need a loan) if they owned the property. One third (N=13) thought it might be almost impossible to prevent damages to the property.

6.2 TAER

The TAER case studies involves the use of all three modules. The SMEs are the target users of Modules I and II, and the surveyors are the target users of Module III. The users of the overall information from Modules I, II III are lenders, insurers, brokers and surveyors. Below we show SMEs feedback from using Modules I and II. We also present in this section the feedback from LIS-B in relation to whether the output report of Modules I, II, and III contributed to increase trust on the specific SMEs, which could result in offering insurance products. An important note is that all but one Case study do not have insurance either because accessibility or affordability.

6.2.1 SMEs experience of Module I - Learning suites

The first step in the case study procedure, was to provide each Case study (SME) with the link to the Learning Suite website. They were asked to use the Learning Suite (**Module I**) to access information, resources, and recommendations regarding SME flood risk and resilience. They were asked to:

1. Rate how useful they found Module 1 in increasing their awareness of flood risks?
2. Rate how useful an SME that has not experienced a flood event before could find Module I in increasing their awareness and knowledge of flood risks?
3. Suggest other information that they would find useful that we should include in Module 1.

All the selected cases have been flooded before, so the participants have engaged with resources before to help with their flood preparedness and post-flood recovery.

Some SMEs (cases 1, 2, 6) have been actively educating themselves, communicating with local authorities and organisations, and participating in flood advocacy. They especially found that the materials in the Learning Suite (Module I) were not useful for them to learn more about flood risk, protection, resilience and recovery. This shows that **some SMEs' flood literacy is adequate**. On the other hand, all the cases agreed that it would be a **useful resource for SMEs that have not experienced flooding frequently or at all**.

In order to increase the value of the Learning Suite (Module I) to frequently flooded SMEs, the participants suggested the tool to include more information on professional flood risk assessment. Many cases suggested the tool to include information on potential costs of damage that flood can inflict on the property and business, especially since it would be more difficult to predict and adjust going forward as climate change may cause more severe flooding that would lead to larger income reduction. Our tool TAEC can provide such information, thus integrating TAER and TAEC can give the SMEs a more rewarding learning experience. This would also be extremely beneficial to SMEs inexperienced with flooding, because this information helps contextualise the extent of damage flood can inflict and the importance of implementing PFR measures and business continuity strategies.

6.2.2 SMEs experience of Module II: self-assessment and record-keeping

By going through the questions and prompts in Module II, the SMEs in the case studies were able to record and evaluate the flood protection measures and strategies they use and assess their business resilience. SMEs found this Module thorough and useful. In the same way, at the workshop, when providing feedback of Module II, LIS-Bs found that this information helped to build a better narrative of the SME's resilience level.

After completing Module II, some participants (Cases 1 and 5) commented that the tool was "*very clear, easy to use and thought provoking*", and it helped them to better understand their own resilience and keep a record of the measures and strategies they employed. It was noted, however, that as the assessment is thorough it was time consuming.

During the design phase, it was brought up in stakeholder interviews and the focus group that the tool needs to accommodate both SMEs that are owning and leasing their business premises. A large percentage of SMEs do not own their business properties (Sakai, 2020), so the tool was designed to ask different sets of questions

according to premise ownership. However, we learned from working with Case 3 that the tool should accommodate landlords and tenants, who are seeking flood insurance and resilience improvement for the property on lease.

Module II provided SMEs with a traffic-light rating system to highlight their level of resilience. Some participants were surprised by the rating they received as it was lower than they expected. It was a convenient way to help the participants gauge their building and business resilience.

6.2.3 LIS-B experience of Modules II, Module III, and Module A-TAEC

During the LIS-B workshop, each participant reviewed the outputs from Module II, Module III, as well as some outputs from Module A from TAEC. The intention of Module II and Module III is to provide LIS-B with the necessary information to inform their decision making regarding the SME's flood resilience and whether an insurance coverage could be offered. All the cases in the pilot study were selected because they are in an area prone to at least one type of flooding, and thus could not obtain flood insurance. To assess the extent of how the tool can modify LIS-B's perceptions, we asked workshop's participants to review the outputs of Module II, Module III and Module A-TAEC of each Case study. Then, participants were asked to provide scores to each Case study. They were asked, on a scale of 1 to 7, how confident they felt about:

- The effectiveness of the resilient works implemented by the SME
- The SMEs' property flood-risk management strategy
- Usefulness of the Module's outputs to offer more accurate insurance pricing

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"The information shows a good risk awareness and appreciation. Also demonstrates proactive mitigation" (Case 2, Participant 1)

"They have a clear plan in place which I think is crucial" (Case 3, Participant 3)

The feedback was very positive. The scorings can be found in the Appendix. Participants commented that the outputs of Module II were informative, and it was found that the cases that provided more and complete information led to higher confidence ratings. The detailed documentation gave the participants more confidence in the SME's attitude and willingness to protect their business, as can be seen in the quote above and below.

> *"The SME fully understands and appreciates their risk." (Case 1, Participant 3)*

Other information that modified participant's opinions on the SME included having good information on a contingency plan or flood plan, showing that the PFR measures are implemented and effective, as well as demonstrating the SME's ability to cope and recover in past flooding events. Module III, the professional building resilience and flood risk assessment, was also highlighted as important for users as 'having data on the design depths and the level of various types of flood risk is important for insurers'. Most LIS-B workshop participants agreed that the pictures were the strongest evidence, especially when they are paired with the written descriptions. Many expressed that they were able to make an evaluation specific to the property based on the written description of the measures and strategies paired with pictures. Another important comment was that the pictures should be captured from more than one angle and accompanied with more detailed description on how the measures are being used. This helps to elucidate a possible rationale behind the measures being taken and estimate their performance. Based on this evidence, they would be able to ask the SME owner specific questions if they need further clarification or give specific recommendations that can really help the SME make improvements to their current conditions.

> *"Good information about the contingency plan they have in place. Would like to know more about the recovery process and how this could be sped up and made more effective." (Case2, Participant 2)*

> *"They have clearly learned from previous experience and have at least taken some measures to protect stock when a warning comes.*

They should give some confidence to insurers that they are increasing their awareness of resilience measures." (Case 4, Participant 1)

The combined information from Module II and Module III also gives the underwriters a better sense of an SME's attitude. As mentioned by a participant, in addition to demonstrating that they have a good flood plan and resilience measures to manage their risks, they need to also show, going forward, how they will be managing, reassessing, readjusting, and retraining. The underwriters can also use the flood risk and building resilience assessment done by a surveyor to evaluate whether an SME has taken actions to manage those identified risks. In fact, the tool was able to reflect well the attitude and the level of involvement of the SMEs during the case study process. The researchers found that the SMEs that invested more time and effort into communicating and providing information with the team received more positive and specific feedback from the workshop participants.

Most participants found the additional information from TAEC Module A very useful for them to make a more confident judgement about an SME's resilience. More information on the damages experienced, how much they cost, as well as other traits of the SME helps to portray a better story of the SME under evaluation. This points to a need for the integration of the two tools (TAER and TAEC).

"The low post flood costs are helpful and reassuring, but in general they seem to be a bit complacent about their risk and not taking as many active steps to reduce it as you'd like to see." (Case 5, Participant 3)

"Despite putting a lot of measures in, they still have high costs following flood events. Interested to know why it took longer to recover back to monthly average in the 2019/20 winter floods than the more severe 2019 incident. (Case 2, Participant 2)"

7 Conclusions, further gaps and next steps

This work responds to the need to provide a wider understanding of the situation of SMEs and flooding. The market failure of imperfect information about SMEs and flooding has been highlighted as a barrier to advance the SMEs flood resilience agenda (Sakai, 2020).

Working in partnership

To bridge the knowledge gaps, **we worked in partnership**. On the one hand, with our Local and Regional Authorities' partners we aimed to find a way to understand the **complete economic costs of flooding on SMEs** and wider aspects about the situation of SMEs when these are flooded. On the other hand, with our partners from the insurance industry, we worked with lenders, insurers, surveyors and brokers to disentangle which information they wanted to have to **increase the trust that SMEs are engaged in self-protection** and open up insurance market opportunities for SMEs.

Through constant engagement and feedback in over a year, **we co-produced two tools**: TAEC and TAER. TAEC (Tool to Assess the Economic Costs of flooding on SMEs) seeks to increase the capacity of local authorities in Yorkshire and the Humber to carry out more complete assessments of the indirect and direct economic impacts of flooding on SMEs, enabling in this way a **consistent methodology across the region** which they can deploy in a timely way to influence their investment plans. In turn, TAER (Tool to Assess the Effectiveness of Resilience Measures on SMEs) seeks to **widen the understanding of LIS-B on SMEs' flood risk management** strategies, including property resilience measures. This will allow them to make more informed decisions based on a wider understanding of SMEs' risks.

Common information needs

We developed two tools based on the gaps in knowledge of LRAs and LIS-B. We learned that those groups, plus the SMEs group share information needs. The **economic costs of flooding** on SMEs were seen as crucial for decision-making and for increasing awareness. LIS-Bs found very useful having information on the economic costs, and SMEs also suggested that in the learning suit it would be good to have more information on professional flood risk assessment and information on potential costs of damage as it helps contextualise the extent of damage flood can inflict. Also, **SMEs ability to recover and their business continuity strategies**, the importance of effectively

implementing **PFR measures,** and some inherent characteristics that make **SMEs resilient** were constantly referred to. The ability to recover quickly post-flooding, i.e. the ability to cope with the impact, is paramount not only for SMEs, but also to LRAs and insurers. The higher the time it takes to recover, the higher the likelihood that damages escalate, and capacities erode.

Assessing SMEs resilience

We learned that both, LRAs and LIS-Bs, as entities that are constantly managing flood risk, would like to know the degree of awareness that SMEs have of their own flood risk and how resilient they are. The interpretation of the stakeholders about what the resilience of an SME means has evolved with the project, and although this journey has been fruitful, work still needs to be done to widen the acknowledgement that **the resilience of SMEs must be assessed with different lenses**. The elements that make an SME resilient to flooding and other extreme weather events are related to the capacity to cope and respond to the immediate incident, as well as the capacity it possesses to implement PFR measures, adapt its premises and processes and renew and learn from past experiences. However, it is important to note that the resilience of an SME is also determined by the resilience of the place where it develops its activities. The information provided by the two tools move us closer to this knowledge. **The tools provide a deeper understanding of SMEs flood resilience; linking them, and sharing outputs among LIS-Bs, LRAs and SMEs could have even wider benefits** to move further the resilience agenda forward. Measuring resilience has always been complex. Resilience needs to be embedded into SMEs business' culture, because it is a dynamic process. The essential aspect is increasing the capacity to cope in the short-term. Put simply, an SME that cannot cope with a flood incident will die. PFR measures are important, and along with professional standards and a proper validation and audit trails are a great first line of defence of SMEs in flood risk areas. **SMEs undertake strategies to better protect their premises** from flooding, and many feel that their businesses are **better equipped** for another flood event, yet their **efforts are not considered** when it comes to insurance. If businesses feel that they are protected and nobody is telling them otherwise (until they are hit), opportunities to improve flood self-protection are missed. The interaction between the case studies and LIS-Bs was a useful assessment for SMEs risks. Returning LIS-Bs' feedback to the SMEs enables a greater interaction with the results, which can enable a **feedback loop, enabling SMEs to further increase their resilience.**

The importance of having systems in place to capture essential data

Another reflection is in relation to the difficulties experienced in the data collection, and the importance of setting up systems before a flood happens -or any other hazard, like a pandemic. Along with Flood Risk Management Authorities, we faced many difficulties in getting the responses of SMEs, in getting the Business Development Teams in their Councils to engage with the project, and in getting information regarding how many businesses were affected in each of the districts by the 2019/20 floods. The latter is a direct input required for TAEC to work. We developed a methodology that can be deployed in a consistent way across Yorkshire and the Humber. However, **the pandemic and flood incidents were happening at the same time of the data collection.** SMEs were either closed or struggling to survive, Business Development teams were overstretched providing grants to recover from flood incidents, as well as managing the pandemic furloughs. Therefore, to be better prepared to manage the pressures of a flood incident and additional unknown pressures in a more efficient way, **the system should be integrated and automatised**. This could help LRAs to collect the data needed in a consistent, timely way, and with considerably less effort.

Further tailoring of the tools

Tailoring the tools requires an additional iteration. We had valuable input in various stages of the project from all the groups, i.e. LIS-Bs, LRAs, and SMEs. Going forward, for **TAEC**, we need to engage more with the **Business Development Teams** of the LAs, and the **Food Risk Management Authorities** of smaller districts. Further tailoring is needed so the outputs are in the form that is most useful to them and build in this way their in-house capacities. In terms of **TAER**, work needs to still be done to actively engage the **brokers**, because they can play a major role in explaining, elaborating, and clarifying to the insurers the information SME provided using the tool, and at the same time helping the SMEs to bring clarity and context to their information. We were not able to fully engage with the **lenders** during the piloting process, nor could we reach **a larger number of insurance underwriters** to test the tool on a wider scale. Another facet of the tool that needs further tailoring is the **scoring and reporting function**. While some SME cases found the simple traffic-light resilience rating system useful, going forward we will fully develop this system. We also wish to integrate TAER and TAEC to enable evidence-based decision making that advances SMEs flood resilience. Overall, this work has shown how a deeper understanding can be gained and societal

benefits can be greater when working in partnership. The path has been paved for taking a more holistic approach of SMEs in flood risk areas, and this journey is ready to follow the next stage.

Main messages

▪ Local, Regional Authorities and lenders, insurers, surveyor and brokers, and academics united efforts to better understand the situation of SMEs and flooding. ▪ TAER and TAEC' outputs give breadth and depth of the situation of SMEs in areas at flood risk. ▪ The tools can help LRAs, SMEs and LIS-Bs identifying opportunities to increase flood resilience. ▪ It is crucial to know the total extent of the economic losses of flooding on SMEs, to prevent those damages go unaccounted for and to direct investments where are most needed.	▪ Yorkshire and Humber SMEs continue experiencing losses because of flood incidents, which calls to increase efforts towards SMEs self-protection. ▪ SMEs learn from past experiences, and it is important to support their swift recovery, so damages do not escalate. ▪ Before, during and after a flood incident, SMEs reported that the most used support was the one provided by the Government. ▪ SMEs in areas at flood risk continue reporting difficulties with insurance, which calls to enable a greater interaction between SMEs and the insurance sector.	▪ Assessments of effective resilience need new lenses, where resilience is seen as a process in which learning is essential. ▪ It is not only about the PFR measures, but SMEs attitudes towards risks and other traits, can reflect the resilience of SMEs. ▪ There is an opportunity to create partnerships between LAs, SMEs and the insurance sector to create a system that encourages trust and enables learning loops on PFR and other flood risk management strategies. ▪ The integration of TAER and TAEC can enable evidence-based decision-making that advances SMEs flood resilience.

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Appendix I

Case 1

On a scale of 1 to 7, how confident do you feel about the following...?

Case 1	The resilient works SMEs implement are effective			The SME's flood risk is properly managed			The information is useful for offering more accurate insurance pricing		
After reviewing:	Module II:	Module III:	TAEC Module A	Module II:	Module III:	TAEC Module A	Module II:	Module III	TAEC Module A
Participant 2: building performance expert	6	5	5	6	5	6	7	7	7
Participant 3: PFR advisory consultant	7	7	7	7	7	7	3	3	3
Participant 1: consultant		3			3			4	

- What is your impression of the SMEs based on Module II and Module III, and whether it has a better chance of getting insurance?
    - The general impression of the SME based on the information provided by the tool is that the SME has made some efforts, and they understand and appreciate their risk. They seem to be realistic about their insurance situation, and are content with not having insurance at the moment.

- If this SME already had flood insurance, would you consider cancelling its policy?
    - Participant 1 said that they would consider cancelling only if the SME didn't take additional measures to be more resilient.

- Does the information provided in the case study change their perspective on the SME? What specific information was the most relevant?
    - Although the flood risk and their personal situation was very well defined, there are many areas that are not covered, for example, they don't have a flood plan and their building use presents some problems.

- In the case of insurance being denied, what information would you like to give feedback to the SMEs? What additional information do you need from SMEs to increase their chances of getting flood insurance?
    - Although it's clear from the information provided that the SME has put thoughts into the actions they have taken, they should consider "talking to a conservation specialist who can help them assess the impact of two actions that may be making their building less resilient than it could be (Participant 2)".

Case 2

Feedback from LIS-B workshop participants:

- What is your impression of the SMEs based on Module II and Module III, and whether it has a better chance of getting insurance?
    - The general impression of the SME based on Module 2 and Module 3 information is that the SME is very proactive and has a good attitude towards flood risk. They have provided great details and insight into the business and demonstrated that they are trying to take care of their business resilience.

- If this SME already had flood insurance, would you consider cancelling its policy?
    - The participants agreed that they would not consider cancelling its policy that it existed already.

- Does the information provided in the case study change their perspective on the SME? What specific information was the most relevant?
    - The participants agreed that the SME has provided good information that can demonstrate their level of risk awareness, proactive mitigation, contingency planning, and previous flood experiences. Additional information about the recovery process would be more useful.

- In the case of insurance being denied, what information would you like to give feedback to the SMEs? What additional information do you need from SMEs to increase their chances of getting flood insurance?

- The participants wanted to know more about the monitoring and management of their flood protection measures on an ongoing basis.

Case 3

Feedback from LIS-B workshop participants:

- What is your impression of the SMEs based on Module II and Module III, and whether it has a better chance of getting insurance?
  - The general impression of the SME based on Module II and Module III information is that the SME has provided good evidence of preparation and have shown that they have taken actions such as taking up PFR measures. This evidence can allow an insurance body to give a favourable decision on the business and property flood insurance.

- If this SME already had flood insurance, would you consider cancelling its policy?
  - The participants agreed that they would not consider cancelling its policy that it existed already, but the SME needs to provide a written flood plan.

- Does the information provided in the case study change their perspective on the SME? What specific information was the most relevant?
  - The participants have found that the most useful information are the design depths calculated by Ambiental, and the information on the PFR measures SME installed.

- In the case of insurance being denied, what information would you like to give feedback to the SMEs? What additional information do you need from SMEs to increase their chances of getting flood insurance?
  - The participants pointed out that the SME should be able to show that the PFR measures installed are tested and proven to be working. If the insurers decided that certain measures have issues of deficiency, they should make the SME and the PFR supplier aware of the issues.

Case 4

Feedback from LIS-B workshop participants:

- What is your impression of the SMEs based on Module II and Module III, and whether it has a better chance of getting insurance?
    - The general impression of the SME based on Module 2 and Module 3 information is that the SME has shown that they have previous flood experience and have taken measures for their own protection. However, the photos show that there are additional problems that should be addressed.

- If this SME already had flood insurance, would you consider cancelling its policy?
    - Two participants said they would not cancel the policy, and one participant expressed that they might consider it.

- Does the information provided in the case study change their perspective on the SME? What specific information was the most relevant?
    - The information SME provides using Module II shows that they are willing to take actions to protect their business, and the information related to the economic impact and losses is also very relevant. However, it would be more useful to also include the plans and sections.

- In the case of insurance being denied, what information would you like to give feedback to the SMEs? What additional information do you need from SMEs to increase their chances of getting flood insurance?
    - The SME should look into general building problems, especially the persistent moisture problems that should be addressed. It was also suggested that the SME can look into more budget-friendly alternatives to the measures they currently take.

Case 5

Feedback from LIS-B workshop participants:

- What is your impression of the SMEs based on Module II and Module III, and whether it has a better chance of getting insurance?
    - The general impression is that the SME has a good understanding of the extent of their flood risk exposure, and seem to be quite confident in their measures. Their costs after flooding are fairly low, which gives confidence to their recoverability. However, there isn't enough information about how the measures are used and if they are well maintained.
- If this SME already had flood insurance, would you consider cancelling its policy?
    - The participants agreed that they would not cancel any existing policy.

- Does the information provided in the case study change their perspective on the SME? What specific information was the most relevant?
    - The flood risk assessment and building resilience survey appeared to show that the SME has a reasonably well-managed risk, and the low post-flood costs are quite reassuring. However, the SME also came off a bit complacent about their risk and should be taking more active steps to be more prepared.

- In the case of insurance being denied, what information would you like to give feedback to the SMEs? What additional information do you need from SMEs to increase their chances of getting flood insurance?
    - The SME should have a written flood plan and demonstrate that they keep reassessing their risks and management. Also, the employees should sign up for flood warnings to avoid complications when the business owner is away or not in reach.

Case 6

- What is your impression of the SMEs based on Module II and Module III, and whether it has a better chance of getting insurance?
    - Participant 2 noted although the industrial units could withstand water entering them and so insurance could be offered, it might not be financially viable since the land could be considered a flood plan.

- If this SME already had flood insurance, would you consider cancelling its policy?
    - Participant 2 suggested the SME to seek advice from a specialist insurer (agricultural insurer) to have a closer look at the viability of the premium and level of coverage compared to their risk profile.

- Does the information provided in the case study change their perspective on the SME? What specific information was the most relevant?
    - While the buildings are fairly resilient, the SME owner should consider seeking advice from a drainage expert as there seem to be too much run-off from the fields. An insurer would also need more in-depth knowledge to fully understand the best line of action.

- In the case of insurance being denied, what information would you like to give feedback to the SMEs? What additional information do you need from SMEs to increase their chances of getting flood insurance?
    - Participant 1 suggested from the point of view of an expert on historic environment that the SME might be able to benefit from looking at the historic land management practices. Participant 2 would advise them to look at parametric flood cover such as Flood Flash, which might be cost-effective for them.

Level of confidence reported by LIS-B

Module II: SMEs self-reporting and record keeping

On a scale of 1 to 7, how confident do you feel about the following...? (★ = not at all, ★★★★★★★ = very confident)

Case 1	The resilient works SMEs implement are effective		The SME's flood risk is properly managed		The information is useful for offering more accurate insurance pricing	
After reviewing:	Module II:	TAEC Module A	Module II:	TAEC Module A	Module II:	TAEC Module A
Participant 2: building performance expert	★★★★★★	★★★★★	★★★★★★	★★★★★★	★★★★★★★	★★★★★★★
Participant 3: PFR advisory consultant	★★★★★★★	★★★★★★★	★★★★★★★	★★★★★★★	★★★	★★★

Case 2	The resilient works SMEs implement are effective		The SME's flood risk is properly managed		The information is useful for offering more accurate insurance pricing	
After reviewing:	Module II:	TAEC Module A	Module II:	TAEC Module A	Module II:	TAEC Module A
Participant 1: Insurance claims manager	★★★★★★	★★★★★★★	★★★★★	★★★★★★	★★★★★★★	★★★★★★★
Participant 2: Government policy officer	★★★★★	★★★	★★★★★	★★★	-	-
Participant 3: PFR Chartered surveyor	★★★★★★	★★★★★★	★★★★★★★	★★★★★★	★★★★★★★	★★★★★
Participant 4: Former insurance underwriter	★★★★★	-	★★★★★	★★★★★★	★★★	★★★★
Participant 5: PFR advisory consultant	★★★★	★★★★	★★★★★	★★★★★	★★	★★

Case 3	The resilient works SMEs implement are effective		The SME's flood risk is properly managed		The information is useful for offering more accurate insurance pricing	
After reviewing:	Module II:	TAEC Module A	Module II:	TAEC Module A	Module II:	TAEC Module A
Participant 1: Government policy advisor	★★★★★★	★★★★★★★	★★★★★	-	★★★★★	★★★★★★★
Participant 2: Business development for Watertight	-	★★★★★★	-	★★★★★★	-	★★★★★★★
Participant 3: PFR Chartered surveyor	★★★★★★	★★★★★★	★★★★★★	★★★★★★★	★★★★★★	★★★★★★

Case 4	The resilient works SMEs implement are effective		The SME's flood risk is properly managed		The information is useful for offering more accurate insurance pricing	
After reviewing:	Module II:	TAEC Module A	Module II:	TAEC Module A	Module II:	TAEC Module A
Participant 1: Consultant	★★★★★	-	★★★★★	-	★★★★★	-
Participant 2: Hydraulic modeller and GIS analyst	★★★★★★	★★★★★★	★★★★★★	★★★★★★	★★★★★	★★★★★★
Participant 3: Building conservation advisor	★★★★★	★★★★★	★★★★	★★★	★★★★★★	★★★★
Participant 4: PFR Chartered surveyor	★★	★★	★★★★	★★★★	★★★	★★★

Case 5	The resilient works SMEs implement are effective		The SME's flood risk is properly managed		The information is useful for offering more accurate insurance pricing	
After reviewing:	Module II:	TAEC Module A	Module II:	TAEC Module A	Module II:	TAEC Module A
Participant 1: Consultant	★★	★★★	★★	★★★	★★★★★	★★

Participant 2: Chartered surveyor	★★★★	★★★★★	★★★★	★★★★★	★★★★★	★★★★
Participant 3: Defra policy	★★★	★★	★★	★★	★★★★★★	-
Participant 4: PFR Chartered surveyor	★★★★★	★★★★★	★★★★★★	★★★★★★	★★★	★★★★

Case 6	**The resilient works SMEs implement are effective**		**The SME's flood risk is properly managed**		**The information is useful for offering more accurate insurance pricing**	
After reviewing:	**Module II:**	**TAEC Module A**	**Module II:**	**TAEC Module A**	**Module II:**	**TAEC Module A**
Participant 1: Building performance expert	★★★★★	★★★★	★★★★	★★★★	★★	★★★★
Participant 2: PFR Chartered surveyor	★★★	★★★	★★★★★★	★★★★★★	★★★★★	★★★★★

Module III: Professional building resilience and flood risk assessment

On a scale of 1 to 7, how confident do you feel about the following...? (★ = not at all, ★★★★★★★ = very confident)

Case 1	**The resilient works SMEs implement are effective**	**The SME's flood risk is properly managed**	**The information is useful for offering more accurate insurance pricing**
Participant 1: consultant	★★★	★★★	★★★★
Participant 2: building performance expert	★★★★★	★★★★★	★★★★★★★
Participant 3: PFR advisory consultant	★★★★★★★	★★★★★★★	★★★

Case 2	**The resilient works SMEs implement are effective**	**The SME's flood risk is properly managed**	**The information is useful for offering more accurate insurance pricing**

Participant 1: Insurance claims manager	★★★★★	★★★★	★★★★★★
Participant 2: Government policy offer	★★★★★	★★★★	-
Participant 3: PFR Chartered surveyor	★★★★★★	★★★★★★	★★★★★
Participant 4: Former insurance underwriter	★★★★★	★★★★★	★★
Participant 5: PFR advisory consultant	★★★★	★★★★★	★★

Case 3	The resilient works SMEs implement are effective	The SME's flood risk is properly managed	The information is useful for offering more accurate insurance pricing
Participant 1: Government policy advisor	★★★★★	★★★★★	★★★★
Participant 3: PFR Chartered surveyor	★★★★★	★★★★★★	★★★★★★

Case 4	The resilient works SMEs implement are effective	The SME's flood risk is properly managed	The information is useful for offering more accurate insurance pricing
Participant 1: Consultant	-	-	-
Participant 2: Hydraulic modeller and GIS analyst	★★★★	★★★★★	★★★★★
Participant 3: Building conservation advisor	★★★★★★	★★	★★★★★
Participant 4: PFR Chartered surveyor	★★	★★★★	★★★

Case 5	The resilient works SMEs implement are effective	The SME's flood risk is properly managed	The information is useful for offering more accurate insurance pricing
Participant 1: Consultant	★★★★★	★★★★★	★★★

Participant 2: Chartered surveyor	★★★★★	★★★★★	★★★★★
Participant 3: Defra policy	★★★	★★★	-
Participant 4: PFR Chartered surveyor	★★★★	★★★★★	★★★★

Case 6	**The resilient works SMEs implement are effective**	**The SME's flood risk is properly managed**	**The information is useful for offering more accurate insurance pricing**
Participant 1: Building performance expert	★★★★★	★★★★★★	★★★★★★★
Participant 2: PFR Chartered surveyor	★★★	★★★★★★	★★★★★

ReSMEs
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