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*The Welsh Marches: resilient farmers?
Exploring farmers' resilience to extreme
weather events in the recent past*



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**The Welsh Marches: resilient farmers?
Exploring farmers' resilience to extreme weather events in the recent past**

Abstract: In the 21st century climate change will cause a significant increase in the frequency and intensity of extreme weather events across Europe. Investigating farmers' resilience to extreme weather events in the past can be used to establish the inherent level of resilience farmers' will have to respond to comparable events in the future. The Welsh Marches has experienced a range of extreme weather events including: heatwaves, flooding; prolonged rainfall; and heavy snowfall. To identify the resilience of farmers in the Marches farmers' apparent vulnerabilities, coping capacity, social capital and adaptive capacity that have been exposed in past events are discussed. Rural isolation is identified as an exacerbating factor of farming vulnerability. Yet, this is also an apparent source of resilience as farmers are found to rely on high social capital to assist each other in emergency and challenging situations during extreme weather events. The paper concludes by indicating that more localised studies are required, situated within unique farming cultures. This will enable a more complete picture of farmers' resilience across Europe to be established.

Keywords: resilience, climate change, extreme weather events, farmers, adaptive capacity, agricultural change.

**Las Marcas galesas: ¿agricultores resilientes?
Explorando la resiliencia de los agricultores ante eventos meteorológicos extremos en el pasado reciente**

Resumen: A lo largo del siglo XXI, el cambio climático causará un significativo aumento en la frecuencia e intensidad de eventos meteorológicos extremos por toda Europa. Investigar la resiliencia de los agricultores a tales eventos en el pasado puede servir para establecer el nivel inherente de resiliencia con que contarán los agricultores para responder a eventos comparables en el futuro. Las Marcas galesas han experimentado una variedad de eventos meteorológicos extremos, incluyendo olas de calor, inundaciones, lluvias prolongadas y nevadas. Para identificar la resiliencia de los agricultores de las Marcas, se discuten cuatro elementos clave a través de la exploración de las vulnerabilidades aparentes de los agricultores, los impactos de los eventos meteorológicos extremos, la capacidad de enfrentarse a problemas, el capital social y la capacidad de adaptación, todos los cuales han sido manifestados en eventos pasados. Se identifica el aislamiento rural como factor intensificador de la vulnerabilidad agraria. Y, sin embargo, esto es también una fuente aparente de resiliencia, dado que se encuentra que los agricultores se apoyaban en el alto capital social para asistirse unos a otros en situaciones de emergencia y desafío durante los eventos meteorológicos extremos. El artículo concluye indicando que se requieren más estudios localizados, situados en culturas agrarias distintivas. Esto hará posible establecer una imagen más completa de la resiliencia de los agricultores europeos.

Palabras clave: resiliencia, cambio climático, eventos meteorológicos extremos, agricultores, capacidad adaptativa, cambio agrario.

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The climate challenge

Resilient communities are less vulnerable to hazards (Cutter *et al.*, 2008). This observation is particularly pertinent to farmers in the UK where resilience is constantly challenged by extreme weather events. The full weight of the exogenous shock of increasingly frequent and intense extreme weather events triggered by climate change is yet to be felt. However, there are existing indications of the need for more resilient farmers' to meet the unprecedented challenge of climate change. Agricultural systems are recognised as continually evolving such that farmers possess a strong tradition in building resilience through strengthening adaptive capacity, primarily driven by the adoption of technology (Bowler, 1985; Evans *et al.*, 2002). Yet, increased technological dependence has done little to reduce overall farm vulnerability to risk (Beck, 1992; Evans, 2013). Extreme weather events have become increasingly common in the UK since the 1950s (Defra, 2012a). Such events have already exerted a notable influence on agricultural production in the UK (Defra, 2012a; IPCC, 2014). For example, it is likely that the frequency of heatwaves has increased across large parts of Europe (IPCC, 2013), alongside the frequency and intensity of heavy precipitation making flooding also a key concern (Defra, 2012a; IPCC, 2013).

Observations indicate that temperatures at the Earth's surface have risen globally, with averaged combined land and ocean surface temperature increasing by 0.85°C between 1880 and 2012 (IPCC, 2013) and 0.5°C to 1°C from 1961-1990 in the UK (Defra,

2012a). Against the backdrop of average climate change trends, the impacts upon social-ecological systems (see below) are amplified beyond the range of disruptions already felt with the emergence of greater weather extremes (Tate *et al.*, 2010). Regional projections for the 2080s indicate that for the West Midlands, the administrative region which includes the Welsh Marches case study area of this paper, there will be increases in mean temperature of 4.4°C in summer and 3.1°C in winter, whilst precipitation will increase by 28% in winter and reduce by 3 to 33% in summer (Defra, 2012a). It is highly probable that such change will be accompanied by an even greater frequency and intensity of extreme weather events than witnessed throughout the 21st century (Defra, 2012b, IPCC, 2013). Such predictions serve to emphasise the mounting challenges farmers face to sustain their own livelihoods and contribute to the broader sustainability of rural communities. If climate related hazards pose enhanced risks, then there will be more importance attached to resilience to climate change (IPCC 2014).

However, the recent emergence of anticipated challenges of climate change to farming (Ambler-Edwards *et al.*, 2009; Foresight, 2011) is amplified by rising concerns regarding global food security. New debates are emerging over the nature of future agricultural change in the UK (Ilbery and Maye, 2010; Maye and Kirwan, 2013; Evans, 2013). Such commentators suggest that more pressure will be brought to bear on UK farmers to step up food production, yet this is occurring precisely at a time when extreme weather events will do more to expose their specific vulnerabilities. These are yet to be assessed at a local level where the resilience of farming lives will actually be played out.

Farming lives: resilient prospects

In its simplest form, resilience is defined as the capacity of a system to experience considerable challenges while retaining essentially the same function, structure and identity (Folke *et al.*, 2002; Walker *et al.*, 2006). Resilience refers to coping with uncertainty in all ways, increasing the threshold of the shocks that a system can endure (Folke *et al.*, 2002). Resilience is conceptualised as a complex notion incorporating risk perceptions, vulnerability, coping capacity, social capital and adaptive capacity to enable the exploration of the flexibility of a system to withstand shocks and change. In respect of recovering from a shock, such as an extreme weather event, Comfort *et al.* (2001) envisage resilience as a flexible response to a threat,

demonstrating an ability of the community or individuals to 'bounce back'. Cutter *et al.* (2008) express this in defining resilience as the ability of a social system to respond to, and recover from disasters. It includes those inherent conditions that allow the system to absorb impacts and cope with events, as well as post-event adaptive processes that facilitate the system to re-organise and change in response to a threat (Cutter *et al.* 2008). In respect of climate change and extreme weather events, it is apparent that there is an increasing need to recognise the necessity of farmers to 'bounce forward' extending beyond the ability to 'bounce back'. Thus a need to re-adjust and adapt the affected system in response to exposed vulnerabilities is increasingly apparent (Gunderson and Holling, 2001).

There is an increasing shift in expectations for farmers to be more resilient to withstand effectively future pressures and shocks that may not yet be known (Kaplan, 1999), including those from climate change. Agricultural resilience comprises three components: the amount of change a farming system can undergo while maintaining its functions and structures (Milestad and Darnhofer, 2003); the degree of self-organisation; and the capacity for adaptation and learning (Milestad, 2003). The term 'farming community' is commonly used in the UK to summarise farmers' shared social, economic and cultural values, yet few studies have considered the relevance of the application of such attributes to assess farming resilience. Darnhofer *et al.* (2010), supported by Sinclair *et al.* (2014), argue that farm systems vary distinctly from other social-ecological systems in that resilience is not simply about preservation of current activities. Therefore, a 'resilient farmer' embraces flexible responses to system shocks (Comfort *et al.*, 2001; Cutter *et al.*, 2008; IPCC, 2014; Sinclair *et al.*, 2014), that enables them to 'bounce forward'. Hence, in response to a shock, there would be reorganization of the current farm system, often within the constraints of culture and tradition, but one which also incorporates actions and measures intended to limit future vulnerability (Milestad and Darnhofer, 2003). Such an approach emphasises the dynamic nature of the concept of resilience, encompassing constant change and evolution of a system's structures and functions. This is particularly notable amongst UK family farms where pressure mounts over the generations to maintain the 'name on the land' (Gasson *et al.*, 1988; Price and Evans, 2006; Riley, 2009).

In more specific terms, the development of resilience is a product of four key elements: vulnerability, coping capacity, social capital and adaptive capacity. This is because resilience demands flexible responses to events exposing vulnerabilities, testing a community's coping capacity and social capitals whilst utilising its adaptive capacity to reorganise and bounce back after a damaging effect (Comfort *et al.*, 2001; Milestad and Darnhofer, 2003; IPCC, 2014). First, the vulnerability of an agricultural system has

been identified as dependent upon its exposure sensitivity to a hazard, combined with its coping and adaptive capacities (Smit and Pilifosova, 2003; Reidsma *et al.*, 2010). As such, a farmer with 'strong' resilience would be expected to have a minimal vulnerability to a risk whereas a high vulnerability would be associated with a 'weak' level of resilience brought about by limited social capital, coping and adaptive capacities.

Second, coping capacity lies in the trajectory between vulnerability and resilience (Lazarus, 2011). Yohe and Tol (2002) interpret coping capacity as a range of circumstances within which the virtue of underlying resilience of a system, reflected in its ability to cope and maintain existing structures and functions, is tested when a significant shock occurs. It is considered to vary dependent upon the community and location, influenced by demographic, social and economic characteristics (Lazarus, 2011). For farmers, coping capacity represents those immediate responses made to a crisis and, as such, are emergency, reactive and short-term (Berkes and Jolly, 2001). The level of an individual's coping capacity is also dependent upon the strength of social capital that exists within their community to buffer adverse vulnerabilities exposed to risk. Agricultural changes made during and in the aftermath of any crisis should, of course, contribute to a greater capacity to cope in the future (Eriksen *et al.*, 2005).

Third, social capital defines trust, networks and shared values that people can draw upon in order to improve their livelihoods, resulting in positive outcomes (Putnam, 1995). A social network is considered to be the pattern of friendship, advice, communication or support existing amongst members of a social system (Valente, 1996). Such concepts allow for the norms of behaviour and trust to be analysed that are critical to understanding farmers' responses to risk and information provided to them (Fisher, 2013). Therefore, they are central to the functions of farming and rural communities (Curry and Fisher, 2013; Fisher, 2013). The importance of social processes and circumstances to cope and adapt to increasing challenges are widely recognised in agricultural systems, playing a key role in enhancing a community's resilience (Smithers and Smit, 1997; Beck, 2010; Moser, 2010). At the same time that social capital and a sense of community can strengthen a farmer's resilience through inclusion, exclusion from a community may further limit the growth of resilience. In an extreme weather event, those who have the equipment and knowledge are more likely to deploy it as a response to help others, whilst those without are left more vulnerable to the adverse effects of that event.

Fourth, resilience supports and enhances the ability of socio-ecological systems to exhibit adaptive capacity (Wood *et al.*, 2013). Adaptation is a powerful option to reduce the negative impacts of climate change (Tol *et al.*, 1998), yet it is only possible with a high level of adaptive capacity. Thus, the adaptive capacity of an affected system

enables appropriate responses to be made to uncertainty and change whilst taking advantage of opportunities for building resilience (Folke *et al.*, 2002; Smit and Pilifosova, 2003). Adaptive capacity is considered to reduce vulnerability through a system's ability to change, enabling appropriate adaptations to be implemented (Smit and Wandel, 2006). It is context-specific and varies amongst communities, social groups and individuals (Smit and Wandel, 2006). The role of adaptive capacity will become increasingly central to farming communities as they are forced to adapt and respond to climate change in order to survive and thrive (Darnhofer *et al.*, 2010; Sinclair *et al.*, 2014).

In light of such conceptualisation of resilience, the objective of this paper is to identify the nature and severity of impacts of extreme weather events upon farmers in the Welsh Marches; the region in the UK where England borders Wales (Evans, 2009). This will enable exploration of an example of farmers' resilience to increasing extreme weather events in the UK. To ascertain the current level of farmers' resilience to the risks posed by climate change, this paper will examine past extreme weather events in the context of each of the four elements that have been identified above as constituting that resilience. Findings will then be discussed through an analysis of farmers' actual resilience to past events. To conclude, the paper will attempt to assess the future level of farmers' resilience in the Welsh Marches in view of the shocks likely to be caused or amplified by the effects of contemporary climate change.

Farmers' resilience in the Welsh Marches

The adoption of a place-based approach to understanding the resilience of farmers is crucial to understanding the culture and experiences in which responses to new events, pressures and shocks are made (Cutter *et al.*, 2008). In turn, this informs the level of resilience within specific farming communities and their ability to respond appropriately to adverse events. In this paper, research within the Welsh Marches is centred on the administrative counties of Herefordshire, Shropshire and Worcestershire. Together, they have a remarkable diversity of agricultural systems and each has experienced wide-ranging extreme weather events. The study area has a strong tradition of livestock production, particularly sheep in the east, beef in the west and dairying in the north. There are varied cropping systems noted for wheat, potatoes, hops and horticulture, including top fruit and cider apples (Evans, 2009). Farm businesses within the region are dominated by family-based labour, with a long history of pluriactivity,

including on-farm diversification (Evans and Ilbery, 1992). The long-established UK trend towards the greater industrialisation of agriculture is evident (Evans, 2013), but the area is also noted for its adherence to traditional farming systems which contribute to areas of high nature-value (Evans, 2009).

A myriad of extreme weather events regularly occurs across the Welsh Marches and they have exerted a noticeable impact over the last decade alone: including heatwaves (2006), flash floods (2007 and 2008), extended periods of rainfall (2012), heavy spring snowfall (2013) and prolonged flooding (2014). This has generated a rich evidence base from which to assess the responses of the farmers to such shocks to their agricultural systems and thus their level of resilience. Climate change is predicted to exacerbate the frequency and intensity of such extreme weather events, heightening the risk faced by farmers. As such, farmers across the region face increasing exposure to comparable events to those already experienced in the recent past. Therefore, it is important to consider farmers' responses to absorb such shocks in the Welsh Marches to gauge their overall level of resilience.

Investigating resilience to extreme weather in the Welsh Marches

An initial step in the investigation of Marches farmers' resilience is to establish farmers' perceptions of the weather based upon past experiences. Indeed, it is envisaged that analysis of primary and secondary data will allow for elements of resilience to be identified that are continually exposed and strengthened through past experiences of extreme weather events. Cultural components of farming activity are particularly important, both directly and indirectly, to the formulation and operation of farmers' responses to extreme weather. This cultural dimension has become recognised by researchers of the geography of agriculture over the last decade as a powerful explanatory factor when unpicking farming activity (Morris and Evans, 2004). In this case, cultural factors exert a key influence over any Marches farmer's risk perception and response to extreme weather. Therefore, farmers have unique experiences of dealing with extreme weather events that have necessitated both some level of short-term coping capacity to absorb shocks and long-term development of adaptations. To investigate these, the research focused upon past extreme weather events that have occurred across

the Welsh Marches through a triangulation of reports published in the local media, quantitative meteorological data and first-hand accounts of farmers themselves gained through semi-structured interviews.

As well as providing accounts of conditions 'on the ground' experienced at the time, local newspapers provide an insight into the flows of information that underpin the construction of new risk perceptions in a community (Wahlberg and Sjoberg, 2000). The purpose of local newspapers can be described as telling a society about itself (Franklin, 2008). The analysis of headline articles published about the weather enables valuable insights to be gained into local events, with the caveat that they need to be understood within the context of the original purpose of publication. The 'newsworthiness' of a weather event is usually judged by an editor according to the positive or negative drama a story can bring to the issue of climate change. This creates a significant bias in the events and impacts reported in the press based on anticipated interest to the target audience (Boykoff, 2007). Relying on the newsworthiness of extreme weather events reported also skews news stories towards those events in which a high level of community vulnerability is exposed. This is apparent because a more resilient system with a higher coping capacity to withstand the shocks of a specific event is unlikely to be as widely reported due to the mitigation of potential losses. It is no small irony that greater adaptation leads inversely to a lower value of newsworthiness, an effect which in itself demands triangulation between scientific records, first-hand accounts and the local media to verify the significance of events that are reported and not reported.

In order to surmount such problems and define a past event as truly 'extreme', it was necessary to establish a base of reference. This was done using local meteorological records held by the UK's Met Office¹, generated from the principal local weather monitoring station in each of the three counties for the period of 1981 to 2011. A 30-year period was deemed appropriate because it is the standard measure of time in which 'climate' is usually defined, allowing the average state of atmospheric conditions to be established (in accordance with IPCC, 2013). The weather records comprised: maximum temperature; minimum temperature; and the volume of precipitation received in 24 hours. Such data were then analysed using SPSS 21 statistical software, calculating standard deviation to identify extreme readings away from the average county climatic range. The 'most extreme' values (furthest away from the norm) for each monitoring

1• The Met Office is the Government agency responsible for monitoring and predicting weather conditions in the UK.

station then provided an index of dates in which extreme weather occurred. This was utilised to interrogate the archive of local newspaper (Shropshire Star, Hereford Times and Worcester News) articles dating from 1982 to 2011.

Newspaper articles that reported specific impacts of the event on farmers within the Marches counties covered were included in a thematic analysis using NVivo10, resulting in a total of 164 articles from the Hereford Times, Shropshire Star and Worcester News. A digital version of each article was directly uploaded into NVivo10 to analyse it in keeping with its original format and context, allowing for a complete assessment of photographs, text, font, style and language. The thematic analysis employed a broad coding frame based upon key themes and the criteria for analysis, but allowed for 'free nodes' to be created when new themes continued to emerge (Bazley and Jackson, 2013). The coding process then enabled the cross-correlation of nodes, creating themes found in the data which could be grouped under the four key elements identified above as developing resilience.

To move beyond the limitations of reported impacts, first-hand accounts of past events were collected through a series of semi-structured interviews. The aim of the interview process was to establish and expand upon farmers' past experiences of, and responses to, extreme weather events. The investigation of the role of coping capacity, social capital and adaptive capacity of farmers in relation to their vulnerability represented the focus of this phase of data collection. A total of 15 interviews with farmers were held across the three counties between 2013 and 2014. The demographic spread of the farmers interviewed are displayed in Table 1. The farmers who took part in the interview process possessed experience on the land of between 6 to 61 years. Most farms were family-run meaning that interviewees were at various stages in their life cycle. This offered up varying degrees of active involvement in farming systems and thus diverse demonstrations of resilience in participants' accounts. Their farming systems included lowland livestock, dairy, arable, pigs, horticultural crops and mixed enterprises. This spanned different land tenure types and farm sizes.

Table 1
Demographics of Interviewees

Demographic	Number of Interviewees
County	
Herefordshire	5
Shropshire	5
Worcestershire	5
Gender	
Male	12
Female	3
Age (approx. Years)	
20-35	3
35-50	4
50-65	3
65+	5
Time On Farm (approx. Years)	
5-10	4
10-19	1
20-29	3
>30	7
Land Tenancy	
Owner	8
Tenant	7
Farm Size (Hectares)	
10- 40	5
40 - 80	5
80-200	1
200- 400	2
>400	2
Dominant Farm Enterprise	
Cereals	1
Dairy	3
Horticulture	1
Livestock	6
Mixed	4

'Shadowed data', considered as the reporting on others' experiences, provide insights into experiences beyond a participant's personal experience (Morse, 2000). This was also found consistently throughout the interviews, with nearly all participants referring to the experiences of farming neighbours and friends in comparison to their own. This is in line with the specific local farming cultures in which the interviewees were situated and investigated, permitting a view of social cohesion which facilitates a consideration of the role of social capital in dealing with such events (Putnam, 1995; Curry and Fisher, 2013). As such, shadowed data were included within the transcripts of the first-hand accounts. These were also subjected to thematic analysis in NVivo10, using broadly the same process as for the newspaper article analysis.

Farmers' vulnerabilities and resilience to past extreme weather events

The nature and ability of farmers to respond to the challenges posed by extreme weather events is now assessed from their experiences over the past 30 years. An illustrative level of farmer resilience to future climate change within the Welsh Marches comes from consideration of exposure to each of the four key elements of robustness to shock identified within the preceding discussion.

Vulnerability

Vulnerabilities are exposed following the impact of an extreme weather event. They are identifiable in specific deficiencies that reduce the ability to absorb and maintain farming system structure and function during a shock. Table 2 demonstrates the most explicit evidence of vulnerability found to have been reported in the newspaper articles. It is apparent that rural isolation is a major factor in contributing to the vulnerability of farmers in the Marches. General dangers and impacts of an extreme weather event are magnified by remoteness, amplifying potential agricultural system losses and the ability of farmers to respond. In particular, during floods and extreme snowfall events, the lack of access roads makes

farmers especially prone to detachment from assistance, as transportation routes are easily blocked (shown in: Hereford Times, 2007b; Shropshire Star, 1982a; Worcester News, 1998).

Vulnerability increases because the ability of emergency services to provide assistance is limited, as demonstrated in Worcester News (1998). In this case, assistance was frequently unable to reach farms and villages during the 1998 floods. Likewise, in the 2007 floods, even where access to remote locations was possible, emergency services struggled to offer much assistance and consequently had to draw heavily upon input from local residents to implement evacuations (Hereford Times, 2007a). The propensity of rural isolation to exacerbate extreme weather is further shown in the Shropshire Star (1982a) which reports the airlifting of food to a farmer and his wife who were trapped for several days on their farm by severe snowdrift. Yet, those vulnerable through isolation tend to recognise this situation of heightened vulnerability, leading to clear examples of enhanced coping capacity (see below).

Other instances of farmers' vulnerability within the Marches are apparent through farmers risking their own lives in attempts to rescue livestock and other members of the wider rural community (evident in the Hereford Times, 2007b; Shropshire Star, 1982b). At times, farmers demonstrate behavior that exhibits considerable levels of risk-taking, for example compromising personal safety in favour of protecting valued livestock. Economic motives do little to explain the extent of risks taken, especially given that most farmers have insurance against 'acts of God'. Rather, it is the emotional attachment a farmer has to the farm, and particularly its animals, that drives farmers' actions (Convery *et al.*, 2005). This is particularly apparent during floods and extreme snowfall events where farmers venture into extreme weather conditions to move sheep or cattle.

"We had twelve rams marooned, so I decided to put the trailer on and tear into the water which was not a good idea... the water started to come into the cab of the tractor so I turned, and tipped the tractor... there was about 2ft of water coming out of the cab... we managed to get out, we thought well them sheep are lost" (Owen, Shropshire).

Table 2.
Evidence of vulnerability in newspaper articles

Source and Headline	Type of Vulnerability	Evidence
<i>Shropshire Star</i> (12th January 1982a) 'Farmers Count The Cost Of Severe Weather'	Flooding	RAF helicopter conducts food airlift to reach isolated farmer and wife trapped in farmhouse for several weeks.
<i>Shropshire Star</i> (11th January 1982b) 'Farmer Dies In Trek To Animals'	Snowfall	Farmer dies due to exhaustion after trekking to provide water for livestock in severe snowfall.
<i>Worcester News</i> (3rd August 1995) 'Desperately Making Hay While The Sun Shines'	Drought	Farmers across Worcestershire face a 'winter of discontent' as drought reduced growth, leaving little to harvest, whilst winter fodder had to be used for livestock to survive the summer.
<i>Worcester News</i> (10th April 1998) 'Bishampton Inundated'	Flooding	Rural roads left isolated after being blocked by flash floods when storm drains on main road across the county failed to cope with a torrential downpour.
<i>Shropshire Star</i> (26th October 1998) 'Mopping Up And Counting The Cost'	Flooding	Search for farmer is called off following his disappearance for three days after venturing into flood water on his tractor to move cattle.
<i>Shropshire Star</i> (8th August 2003) 'Farm Worker Rescued From Tractor Blaze'	Drought	Shropshire farm worker rescued from his burning tractor whilst transporting straw. The man tried desperately to escape the flames after it was on fire but realised his foot was stuck.
<i>Shropshire Star</i> (19th July 2006) 'Fire Crews Tackle String Of Grass Blazes'	Drought	Shropshire farmer speaks about the terrifying moment he turned away from his combine harvester and saw a fire ripping through his cornfields.
<i>Hereford Times</i> (28th July 2007b) 'Heroes Praised As Community Pulls Together To Help Others'	Flooding	'Local heroes', in particular farmers, who assisted in rescuing other community members are praised for their efforts in flood evacuations.

Indeed as Owen demonstrated in an interview when discussing his response to the 2008 floods, unplanned and impulsive responses to extreme weather events were found to inadvertently place a farmer at further risk. Two incidences are also found from the newspaper articles, where attempts to move livestock resulted in loss of life: the severe snowfall of 1982 (Shropshire Star, 1982b) and the flash flooding of 1998 (Shropshire Star, 1998). In the latter case, a farmer became stranded in his tractor close to the swollen River Wye when moving cattle to higher ground. Such attempts at responding to extreme weather conditions increases risk, sometimes all too clearly to the point where tragedy ensues.

If resilience becomes built into responses to known hazards, then it is the unknown hazards that do most to expose vulnerabilities. Numerous 'hidden hazards' are found in relation to weather events, where farmers' lives are exposed to risks not usually considered. Several examples of farm fires are apparent where fire tears through crops and grasslands, as well as tractor blazes which are started during drought conditions by a single engine spark (Shropshire Star, 2003, 2006). Farmers are also found to risk their lives further using their own equipment to assist others, essentially acting as an informal rescue service (Hereford Times, 2007a). Nowhere in the academic literature is this type of action acknowledged as a response to flood risk. Yet, it exposes individual vulnerabilities that are greater amongst farmers than other rural residents as they seek to plug deficiencies in community resilience in the absence of support from formal rescue and recovery services.

First-hand accounts of past responses to extreme weather events reveal vulnerable attitudes that may delay or limit a farmer's response to an extreme weather event. In short, feelings of risk may exceed the perceived benefit of response (Solvic and Peters, 2006). Fatalistic attitudes are apparent, making it less likely that a farmer will act upon and make logical decisions to limit the impact of extreme weather on their farm system or contribute to mitigation at a wider community level (Mertz *et al.*, 2009). Several indications are apparent of farmers in the Marches associating both negative and positive experiences with past extreme weather events to luck, lying beyond their control. If a farmer feels as though the impacts are beyond coping capacity, then the ability to make adjustments in response to adverse impacts are also likely to be limited (see also Mertz *et al.*, 2009). Farmers further use this as a justification against immediate responses and adaptations:

"I just hope it doesn't happen again, and we just got to hope it settles down... there's not a lot that we can really do is there?" (Barry, Herefordshire).

A feeling of helplessness reduces a conscious response following an event, doing little to improve resilience to the shock being experienced whilst simultaneously exacerbating vulnerability to comparable future events (Solvic and Peters, 2006).

Coping Capacity

Despite the aforementioned vulnerabilities, it is apparent that farmers' in the Welsh Marches have a high overall coping capacity. This is evident through displays of preparedness, shocks absorbed in farming systems and the ability of farmers to respond to assist the wider rural community during an event. Table 3 demonstrates the evidence of coping capacity found from the newspaper articles.

A farmer's preparedness describes those actions taken immediately prior to an imminent event, and therefore plays a crucial role in an individual's coping capacity. It is important to note that this preparation period may consist of implementing pre-planned emergency measures. Informal measures are often adopted last minute as responses to 'gut' feelings. In the case of livestock systems, cattle and sheep are often moved to higher and safer ground as precautionary measures just before or at the onset of an event. Hence, in the Shropshire Star (2000a), a tractor is seen moving bales of hay away from flood water. Sometimes, formal warnings are also issued in local newspapers, prompting appropriate immediate responses to be made. An article in the Hereford Times (1987) advises farmers to prepare for heavy snowfall, as demonstrated in the headline instructing farmers to *"Make Plans Now For Stock Feed"*. During events, urgent responses by farmers to mitigate against the full effects of weather impacts on their farm are also apparent. This is shown in the headline that *"County Farmers Face Battle To Save Crops"* in the 2008 floods (Shropshire Star, 2008), as well as in the *"superhuman attempt"* to rescue sugar beet from severe snowfall and flooding (Worcester News, 1982). Responses in the aftermath of an event are evident where a farmer's coping capacity has been exceeded and emergency services have been involved to provide assistance (Hereford Times, 2007b). Community 'clean-up' recovery options are also widely reported; particularly it seems after flooding (Shropshire Star, 2008).

Table 3.
Evidence of coping capacity in newspaper articles

Source	Evidence
Worcester News (2nd January 1982) 'Local Beet Crop Saved From Ruin'	A 'superhuman' effort for harvesting sugar beet saved most of the local crop from ruin in spite of snow, ice and flooding across the county.
Hereford Times (15th January 1987) 'Make Plans Now For Stock feed'	Article urges farmers to prepare for heavy snowfall.
Shropshire Star (1st November 2000a) 'Tony Dawson Finds A Way Of Getting Bales To His Stock At His Farm At Llandrino'	Shows pictures of tractors moving hay bales to drier land in rising flood waters.
Shropshire Star (31st October 2000b) 'Tractors And The Buckets Of Diggers Were The Only Transport Available'	Farmers play a key role in ferrying residents to safer ground as part of evacuations from flooding. Emergency services were unable to get to villages in time to assist.
Shropshire Star (30th October 2000c) 'Fire Crews Struggle To Clear A Mud Slide On The B4390 Near Newtown'	Farmers shown to be assisting in clearing a road blocked by flood debris.
Hereford Times (28th July 2007b) 'Heroes Praised As Community Pulls Together To Help Others'	Local heroes, in particular farmers who assisted in rescuing other community members, are praised for their efforts in flood evacuations.
Shropshire Star (9th September 2008) 'County Farmers Face Battle To Save Crops'	Farming community attempts to rescue crops from floodwaters and minimise flood damage.

It is evident that farmers in the Welsh Marches are highly self-sufficient, being able to extend their coping capacity beyond absorbing the shocks experienced at a farm-level to support the wider farming community (see discussion of social capital). Local knowledge is shared and equipment used in emergency situations, indicating high coping capacity and social capital. Numerous examples across the local newspapers demonstrate that farmers hold considerable reserves of coping capacity in acting as an emergency rescue service (identified under vulnerability) to provide immediate

assistance to members of rural communities. Instances are evident where farmers are praised and labelled as "heroes" by the local press for providing such assistance (Hereford Times, 2007b). By taking such actions, farmers create an informal fifth emergency service, making an initial contribution to rescue operations before emergency services become available.

Nevertheless, some extreme weather events have rapid unexpected impacts, and it is with these that farmers require most urgent assistance from emergency services. Sudden-onset events include flash floods, extreme snowfall and blizzards, and grass or crop fires triggered by drought. During the 2000 Shropshire floods, the assistance that farmers gave to the rescue and recovery operation of local rural communities is widely reported (Shropshire Star, 2000b). It became apparent that tractors were the only mode of transport able to pass through the flood water. The Shropshire Star (2000b) reports:

"Residents were catching a lift with farmers who were helping to evacuate homes... as tractors were the only vehicles that were able to get into and out of the hamlet of Pentre" (Shropshire Star 2000b).

This newspaper contains further details of the dramatic rescue of a local resident and his son who had to climb into the bucket of a farmer's tractor to be rescued from the flood water. Additionally, farmers have been found to assist the emergency services directly. The Shropshire Star (2000c) shows a farmer assisting a fire crew to clear a road. Indeed, a farmer's local knowledge of the environment, land and community may provide vital informal assistance, ensuring a smooth and prompt clean-up operation. Therefore, a high level of resilience is demonstrated to derive from farmers' inherent coping capacity in emergency situations as they utilise their machinery and knowledge to assist others in local emergencies as demonstrated by Frank in regards to the extreme rainfall experienced in 2012:

"Well I think that was a once in a lifetime experience that...we have never experienced continuous rainfall like it...but if that's what's thrown at us you have to have contingency plans" (Frank, Worcestershire).

Farming has long been considered as a risky business and stressful operation, the result of numerous unpredictable factors (Sutherland and Glendinning, 2008; Price and Evans, 2009). This undoubtedly contributes to farmers' coping capacity and accounts for the greater number of newspaper reports demonstrating it than with the rural public at large. Indeed, Elder and Conger (2000) show that the dynamic of being integrated into a farming community results in a resilience to stress that exceeds that of the rural non-

farm population (see also Sutherland and Glendinning, 2008). Therefore, it is perhaps unsurprising that the rural non-farm population come to rely upon the farming community for assistance in emergencies, as reported in local newspapers across the Welsh Marches.

Social capital and social networks

Social capital is demonstrated in this research through farmers exhibiting extensive webs of community ties and a keen sense of belonging, extending out to assist others (as discussed in regards to emergency responses; see also Curry and Fisher, 2013). It is apparent that farmers are highly self-sufficient in extending their coping capacity beyond absorbing shocks that are simply experienced at the individual farm level. They provide support to the wider community through the 'bridging' of social capital (Fisher, 2013). This is demonstrated through the sharing of local knowledge and use of equipment in emergency situations (see Shropshire Star, 2000b, 2000c). There are numerous examples where the capacity of an individual farm system to respond to a particular event is exceeded. Farmers' resilience is then displayed through social capital, social networks and knowledge transfer. Together they act as a buffer, strengthening individual coping capacity through absorption into the much greater resilience of a 'community' as a whole. An individual's resilience is limited within the bounds of their own knowledge. A farming community's resilience exceeds that of an individual by virtue of the social capital and financial and physical resources (amongst other things) it contains. The evidence in this study shows that feelings of being involved in the local community and its networks enable an individual farmer to increase coping capacity. Specifically, shocks from extreme weather events that extend beyond an individual's coping capacity can still be absorbed if community assistance is drawn upon:

"With the immediate farming community, we all have a very good relationship and I feel as though we could ask them for help if necessary" (Bonnie, Worcestershire).

This demonstrates that such a relationship with the local community acts as a buffer. A community's coping capacity strengthens an individual's ability to absorb and cope with immediate shocks through support within the social network mitigating individual vulnerabilities, creating a relatively 'high' level of resilience (Cutter *et al.*, 2008). In direct contrast, one farmer interviewed who displayed a comparably 'low' level of resilience to repeated flooding on his land also possessed a low level of social capital.

He had little involvement in any farming community and poor relationships with neighbours. Such behaviour is often associated with being opposed to the 'belonging' or 'bestowing' qualities of social capital (Curry and Fisher, 2013). Therefore, during frequent flooding, such isolation through a lack of social capital and support means that vulnerability is considerably heightened due to an individual's inability to rely on others to assist in emergency measures, such as moving livestock to higher ground to minimise potential farm losses. It is noticeable that the inclusion of a farmer within the local community, generating much social capital, can strengthen resilience particularly when responding to immediate shocks from extreme weather events. This is demonstrated by Luke's use of social capital to consider the further strengthening of his resilience upon establishing adaptations made by his neighbour:

"I didn't realise that my neighbour had already vaccinated his sheep for the damp, and I said in hindsight if I had known that he had done it, maybe I would have bit the bullet and done it too... someone has to do it first I guess but you do need to have the capital to invest first" (Luke, Worcestershire).

Alternatively, exclusion and isolation from a community can instead act as a barrier to resilience triggered by a low social capital, considerably reducing an individual's coping capacity to respond. This is shown by Frank, who unlike Luke above, is struggling to use his social capital to make suitable changes in response to recent shocks:

"I shall take advice from I don't know who yet. Because all the people I use to take advice from are all gone... I know I have to do something, but I don't know what yet" (Frank, Worcestershire).

Community scale responses are evident in numerous reports in local newspapers. An article written after the 2008 flash floods (Shropshire Star, 2008) demonstrates how the farming community came together to help in the clean-up operations, clear roads and co-operate to save as many crops as possible. A farmer's ability to access new sources of knowledge and to share local knowledge within a social network are amongst the most important direct benefits of their social capital (Inkpen and Tsang, 2005). In the Welsh Marches, it appears farmer groups, such as breed societies and local branches of the National Farmers Union (NFU), provide a platform for knowledge transfer. Many interviewees appear to have engaged with them and casually swap information about weather conditions and mitigating actions alongside the discussions that form the main focus of the group. Farmers become used to asking pertinent questions within such networks, with such principles extended to cover advice on responding to extreme

weather and climate change. For example, Melissa optimises her interaction with other farmers through a breed society, comparing her activities with other members through asking a series of questions:

"We rely on the Breed association a lot for information... I mean, for what they're doing for lambing, how has that gone? What feed have you used? When are you having yours scanned?... always comparing – seeing what works for some people and not for others" (Melissa, Worcestershire).

Undeniably, farmer groups utilise such knowledge transfer to disseminate information about problems, ideas and solutions to address potential vulnerability (Chambers *et al.*, 1989). Social capital also appears to enhance resilience through its encouragement of resilient attitudes. This is particularly apparent in individual descriptions of losses incurred by an extreme weather event. A significant loss is often relative not only to an individual's past experience, but also to the experiences of those within their social and knowledge networks. It results in a 'could have been worse' attitude. For example, Isaac considered himself to be 'lucky' in comparison to his neighbour:

"My neighbour lost almost 300 ewes, I was lucky – I only lost 30 lambs" (Snowfall 2013, Isaac, Shropshire).

When impacts are placed in respect of others whom may have had more significant losses, a resilient attitude emerges of being in a position of smoother recovery, with greater latitude to implement response measures.

Adaptive Capacity

Most adaptation to climate change is reactive, triggered by past events (Adger *et al.*, 2005). Therefore, responses to past extreme weather events build capacity and strengthen resilience of farmers in the Marches to future events. Displays of adaptive capacity are more covert and difficult to identify because frequently they are more readily apparent in the responses a community is able to make (see coping capacity) which also reduce exposure of vulnerability. Such changes made after an event are highly individual, yet they are often congruent with those made by other farmers. Table 4 demonstrates the evidence of adaptive capacity found from the newspaper articles.

Table 4.
Evidence of adaptive capacity in newspaper articles

Source	Evidence
Hereford Times (18th August 2006) 'With Dry Weather Comes Stress'	Demonstrates how drought forced farmers to take on additional work to make up for the loss of income created by using winter feed and a reduced ability to make hay and silage.
Hereford Times (26th July 2007c) 'Counties Farmers Are Facing Difficult Conditions'	Documents a range of impacts from flash flooding experienced by the farming community, in particular loss of fruit, cereal crops and livestock housing.

It is apparent that farmers in the Welsh Marches decide to trial on their land something that they have seen implemented successfully elsewhere, usually originating from within their social networks. This leads to clusters of innovators closely integrated with each other (Chambers *et al.*, 1989; Reij and Waters-Bayer, 2001). Potential farm adjustments to extreme weather events are considered in this way by the interviewees. For example, this was revealed by one farmer who would have definitely implemented a disease protection measure on the basis that his neighbour had done so. Specifically, the Schmallenberg virus causes birth defects and stillbirths in livestock and was identified as a new threat in the UK in 2012 when it started to be detected on farms in the east of the country (according to the UK Government's agricultural department (Defra), its origin was from midges carrying the virus crossing from the European mainland as a result of warmer climatic conditions);

"There are lots of different things that we communicate about, like Brian said to me the other day – I didn't realise that he had already vaccinated for Schmallenberg...and I said actually in hindsight if I had known that he was, then I would have bit [sic] the bullet and maybe done it too" (Luke, Worcestershire).

As demonstrated by Luke, the communication process and the source of information from within a social network is emphasised as essential, resulting in the implementation of adoption and confirmation of its success (Rogers, 2003).

Long-term impacts of extreme weather events can result in more reason to bring about a change to the farming system which is inherently adaptive. A high

coping capacity appears necessary to enable the changes required to reduce vulnerability. Such adjustments may include sourcing alternative incomes, demonstrating where adaptations had been made in direct response to those exceeded when attempting to maintain the original system. This is identifiable for farm families after the 2006 drought (Hereford Times, 2006), where the dry weather meant that winter stores had to be used throughout the summer. This forced some Herefordshire farm households to seek temporarily additional incomes to make good the financial deficit incurred from feed use in a period of unusual weather. Indeed, this was also found to have been experienced as an impact of the 2012 rainfall by two interviewees:

"My wife had to get a job [last year] because you don't know what's gonna happen. You can't factor in 16 floods in 14 months. You can't... especially in the summer. The weather's just not there that's why we had to take on extra work" (Owen, Shropshire).

"We are still struggling from that now... I feel quite fortunate that we have a bank manager who is understanding" (Phillip, Shropshire).

Other adaptations are indirect, implemented primarily as a response to other drivers of change in the agricultural sector. This can lead to situations where one farmer suffers no loss compared to others in the local area. Spanish polytunnels have been appearing in the English landscape since 2001 primarily as a grower response to supermarket demands for large quantities of high quality strawberries (see Evans, 2013). In changing to such a system, additional benefits can be enjoyed by growers, not least in relation to protection from extreme weather:

"Thank goodness for polytunnels: we have been able to continue picking" (Hereford Times, 2007c).

In this case, a farmer's adaptive capacity is already displayed to have previously protected the farm system in comparison to other farmers within the Welsh Marches. Thus, although one individual displays a high adaptive capacity, the resilience of surrounding farmers is not enhanced due to a lack of wider adoption of innovations. Yet, adaptive capacity is highly complex, extending beyond social and cultural capital which is determined at a community level to include physical, natural and economic capitals (Edwards-Jones, 2006). Unfortunately, a holistic assessment of individual adaptive capacity is beyond the scope of the current paper.

Conclusions

The resilience of farmers across Europe will undoubtedly be tested through a significant increase in the frequency and intensity of extreme weather events, as climate change has a notable effect on the ability to continue producing food. This paper has attempted to conceptualise farmers' resilience through a focus upon the vulnerabilities, responses and adaptations of farmers in the Welsh Marches, to extreme weather events experienced in this locality. The use of local newspapers has allowed for resilience to be assessed through a lens derived directly from the culture, identity and challenges of the locality at the specific time of event occurrence. When combined with first-hand accounts of past experiences, an assessment of resilience has been constructed utilising both primary and secondary data. Digital thematic analysis has allowed for direct comparisons and assessments to be made of multiple sources from within their original context.

Through assessment of responses of farmers to past extreme weather events, the dynamics of farmers' resilience have been explored. The nature and ability of farmers to respond adequately to such challenges are then revealed. One outcome of the analysis provided here is that farmers in the Welsh Marches can be regarded as highly self-sufficient in their ability to overcome the risks presented by extreme weather, as well as possessing capacity to meet the needs of wider local rural communities. At the same time as rural isolation is seen to exacerbate the vulnerability of a small number of Marches farmers, it is also a source of resilience. This has been demonstrated through a high level of social capital, ensuring that the coping capacity is heightened, which then allows for the absorption of external shocks to the farm system. Adaptive capacity to past extreme weather events is apparent amongst those farmers interviewed. However, the extent of adaptations made in direct response to the adverse impacts from future climate change is yet to be explored within the diverse farming communities of Europe. Farmers' resilience is developed using coping and adaptive capacities in combination with the support provided from a social network. A fundamental finding from the analysis of primary and secondary data presented in this paper is that such elements of resilience are continually exposed and strengthened through past experiences of extreme weather events. Unfortunately, they may not be recognised by the individual farmers themselves. Thus, the ability of farmers in the Welsh Marches consciously to

enhance their resilience as a specific response to the growing pressures of climate change appears limited.

Further research is required to explore climate change resilience in view of present and anticipated challenges facing farming, along with developing an understanding of appropriate adaptations. The Welsh Marches locality has been used to illustrate key elements of resilience through displays of adaptations in response to extreme weather events. As resilience is regarded to be place-based (Cutter *et al.*, 2008), so are hazards. Undoubtedly, climate change, and in particular extreme weather events, will precipitate unique geographical impacts across farming systems in Europe. Therefore, in order to further inform an overall assessment of farmers' resilience, more research of the type presented here is required within the contexts of localised farming cultures.

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