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Factors influencing the assessment of **tourism damage** caused by **river floods**

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Abstract | Studies analysing the impact of river floods on tourism are scarce and usually approach the impact of such phenomenon on tourism as one of the affected industries. Floods on inland places, as fluvial floods, also affect tourism, particularly on what concerns to tourists' perceptions of risk. In this context, the present work addresses the effects of flooding on tourism in inland areas. Damage influencing factors are classified as impact parameters and resistance parameters to obtain an initial assessment of damage to tourism. A case study was carried out in the city of Ourense (Spain) which features spas and thermal facilities located on the river banks. Tourism's dependency on natural, thermal resources, combined with the fact that such attractions are irremediably located on flood zones, increases the sector's vulnerability to inundations.

Keywords | Damage assessment, flooding, river flood, spa, inland tourism

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1. Introduction

The tourism sector, by nature, depends on territorial and environmental attributes, and is closely related to local societies. Man-made crises and natural catastrophes significantly affect tourist demand (Abdula, 2019). Moreover, tourism is highly sensible to weather conditions and global climate changes (De Freitas, 2003; Scott & Lemieux, 2010). Therefore, tourism is a vulnerable sector, and may suffer severe loss due to natural phenomena such as floods (Agnew & Viner, 2001; Espiner & Becken, 2014). Studies analysing the impact of floods on tourism normally approach the activity as one of the affected industries (Merz et al. 2010; Yeo, 2002) and focus on marine and coastal floods (Kellens et al. 2011; Toubes et al. 2017). This phenomenon offers risk to the population in general, including both residents and tourists (Sayers et al., 2013).

Any area where recreational activities are carried out in fresh water by a significant number of people is also vulnerable to this phenomenon (WHO, 2003). Regarding inland areas, the most common recreational uses of fresh water are: bathing/swimming, recreational fishing, recreational sailing, and uses related to medicinal properties of thermal water (MAPAMA, 2017). An increasing body of literature has addressed the impact of floods focus on the affected assets, such as campsites, caravan parking lots, river beaches, water sports, resorts and accommodation establishments (Bernard & Cook, 2015; Fitchett et al., 2016; Southon & van der Merwe, 2018; Yeo, 2003) and Faulkner and Vikulov (2001) refine the model of disaster management in tourism and apply it to the case of the floods in Katherine (Australia). However, the issue remains underexplored and more research are needed on inland rain-derived floods to analyse potential and indirect impacts on the tourist activity caused by damage to heritage sites, natural spaces, tourist facilities and local infrastructure. Flood experiences may also influence the perception of risk, and thus, become a threat to consolidated tourist destinations (Walters et al., 2014).

Understanding what is at risk and assessing the impact of the damage is the first step in identifying vulnerabilities. The thermal and spa sector has provided a boost to sustainable tourism in inland and peripheral areas. Floods are a territorial problem for which local communities must seek effective solutions and develop prevention strategies to increase the resilience capacity of the destination. Flood damage assessment and vulnerability analysis of territories at risk can help address these problems and make communities more sustainable in line with objective 11 of the sustainable development objectives (SDOs) for 2030.

The present work follows Merz et al. (2010) suggestions regarding flood damage evaluation, and are applied in a novel way to the context of inland tourism. Focusing on the case of river floods, damage influencing factors are classified as impact parameters and resistance parameters to obtain an initial assessment of damage to tourism.

2. Theoretical framework: Flood damage assessment in inland tourism

The assessment of flood damage is necessary for the development of vulnerability analysis tools, such as risk maps, as well as for calculating insurance prizes. Besides the economic aspects, such evaluation must consider the social, cultural, environmental and political dimensions. Therefore, damage evaluation is a complex endeavour, not less because it relates to heterogeneous elements that affect vulnerability, such as climatic oscillations and socioeconomic factors that might intensify or mitigate the damage (Khan, 2011; Yu et al., 2009).

2.1. Types of flood damage

Flood impacts to the tourism industry include the decline of visitors' numbers and consequent business loss, damage to facilities and local infrastructure, and substantial rebuilding costs (Bernard & Cook, 2015; Fatti & Patel, 2013; Hamzah et al., 2012). Floods may cause direct and indirect damage to tourism. Direct damage refers to the interruption of business activities due to the direct physical impacts of flood water on facilities (Merz et al., 2011). Indirect damage is caused by floods, but not in the same of time period and place as the disaster. Flood damages to the tourism industry are also classified into tangible or intangible. Tangible damage includes both direct and indirect damage that can be evaluated in monetary terms without any significant difficulty. Despite the clarity of planning, there are practical difficulties and a certain confusion in the classification of damage as direct or indirect, as well as tangible or intangible (Jonkman et al., 2008).

The indirect costs are difficult to quantify and may have effects over months or even years. In the short term, floods cause indirect, economic damage through the decrease of consumption and consequently, of income, due to the interruption of business activities. Floods may also cause indirect impacts on the long term, namely, through changes in: tourist behaviour and destination choice (Jeuring & Becken, 2013; Tol et al., 2013), communication and promotion channels, the local community, local jobs and public budgets. In this context, in order to effectively evaluate the damage cause by floods, it is necessary to carry out a dynamic adjustment, which is normally not included in the existing damage evaluation models (Merz et al., 2010). In order to measure the indirect costs, some studies employ data from public aid and insurance companies. However, such data is of limited use, as it does not include the biggest part of indirect effects. Moreover, many companies do not have business interruption insurance (Merz et al., 2010).

2.2. Exposure and susceptibility analysis

The first step to estimate flood damage to the tourism sector is defining the study's spatial and temporal limits, as the damage evaluation results may change according to such limits. For example, a flood may negatively affect the tourist activity in a particular locality, but also cause an increase in visits to neighbouring destinations. In this context, from a broad enough temporal and spatial perspective, the economic damage caused by the disaster in one locality is compensated by the increase caused in others. On the other hand, an evaluation adopting a narrower spatial perspective would super estimate the total damage by focusing on the directly affected destination.

Once these limits are defined, it is necessary to establish the baseline. As each sector has specific characteristics, it is important to identify the assets of tourism that have been affected (ECLAC, 2003). The assets' susceptibility also differs according to the sector. For instance, the elements at risk included in the "infrastructure" and "public utilities" categories are common to many sectors. However, there are important differences to be considered when evaluating the impact of damage to those assets on tourism, agriculture or the manufacturing industry. Therefore, it is necessary to have detailed information on the elements at risk, namely: number, capacity and relevance; as the distribution of damage and affected elements often follows a Pareto distribution. This means that 20% of the affected elements correspond to 80% of the total damage (Merz et al., 2010). The grouping and classification of elements at risk is based on the judgement of specialists in the field. Table 1 presents the elements at risk in the tourism industry for rain-derived floods.

Table 1 | Elements at risk of tourism sector with river flood event

Service sector	Facilities	Infrastructure	Others
hotels	spas	transportation	ecosystems cultural heritage
restaurants	campsite and caravan	communications	clean-up costs
travel	parks	water supply	cost of promotional campaign
agencies	rest and recreation areas	sewerage and	increase in insurances
tour operators	swimming pools	drainage	damages to flood defence
	sports centres	gas and power supply	structures

Source: Adapted and extended from ECLAC, 2003; Merz et al., 2010

The damage evaluation is carried out homogeneously in terms of the elements of each class and considering the different types of damage: direct and indirect; tangible and intangible. Adopting this classification, Merz et al. (2011) proposes the following list of elements at risk in the tourism industry:

- Direct, tangible: damage to accommodation establishments, restaurants, bars and facilities; destruction of infrastructure such as paths, roads and railroads; business interruption inside the flooded area; evacuation and rescue measures; clean-up costs.

  Direct, intangible: damage to cultural heritage; negative effects on ecosystems.

- Indirect, tangible: disruption of public services outside the flooded area; business losses to companies outside the flooded area, e.g. cancellation of tour operators and suppliers of flooded camping and hotels.

- Indirect, intangible: media coverage; negative perception; business closure due to lack of resilience.

Besides the nature of the affected elements, other factors influence the damage caused by a flood. For instance, in the case of tourism, the time of the year (high season or low season) and duration of the flood are particularly relevant for the evaluation of its impacts (Förster et al., 2008). The damage functions relate the damage (to each element at risk) to its main influencing factors and to the flood characteristics (see Table 2). Damage influencing factors can be classified as impact parameters and resistance parameters (Thieken et al., 2005). Impact parameters reflect the specific characteristics of a flood event to the object of study and depend on the type and the magnitude of the flood. Resistance parameters represent the capacity of an element to resist the impact of a flood. They depend on the characteristics of the element at risk and their likeliness to flood (Ghaderi et al., 2015). Considering that the various influencing factors are not independent from each other, a multivariate analysis is necessary (Merz et al., 2010).

In certain cases, there are two additional impact parameters, and corresponding damage to be considered: the possible water contamination, for example, in the case of flood reaching engine rooms or fuel tanks; and potential debris or sediments in recreation areas on river banks, which increase the costs with cleaning and repairing the affected areas.

Table 2 | Damage influencing factors considered in river flood damage assessments for tourism

Impact parameters	Description
Duration of inundation	Direct and indirect damage to the tourism industry in the affected area are directly proportional to the duration of the flood.
Inundation depth	The likeliness of damage to assets and property is directly proportional to the inundation depth.
Frequency of inundation	The frequency of flood events may have negative effects on destination image. On the other hand, the destination improves its capacity to face future floods, as flood experience may also be considered a resistance parameter.
Timing	The time of the year in which a flood event happens influences the magnitude of the damage. Floods during the high season and vacation time affect a higher number of tourists and cause greater business loss.
Resistance parameters	**Description**
Use and type of building	State/level of preparation. For example, a flood in a recreation area with a pool presents lower damage potential than one at a restaurant.
Precaution/ Mitigation measures	Measures that may significantly mitigate the damage caused by the flood, such as construction of dikes and transportation of elements at risk to higher altitude areas.
Early warnings	With enough warning time, the mitigation measures may be particularly effective, as the water levels are still low.

Source: Adapted and extended from Merz et al., 2010

3. Case study

Floods are the most significant natural disasters in Europe (EEA, 2004). In the case of Spain, floods caused by torrential raining, alongside droughts, are the natural hazards with greater socioeconomic and territorial effects (Olcina, 2008). Such phenomenon causes an average of 20 victims annually, as well as 800 million euros worth of economic loss (MAGRAMA, 2016). Floods' effects may indeed be mitigated. However, they cannot be completely avoided. In the case of river floods, the risk may be decreased by weakening water flows through reservoirs and dams. On the other hand, the risk might be increased by a combination of climatic factors. Accordingly, the vulnerability of territories may be aggravated by socioeconomic issues (Alfieri et al. 2016). Studies on this phenomenon in the Iberian Peninsula (Roudier et al., 2016), namely in the north of Spain (Alfieri et al., 2015; Arnell & Gosling, 2016; Hirabayashi et al., 2013), show that global warming will increase the risk of flooding in a return period of 100 years.

The case study analyses the urban section of Miño river that passes through the Ourense (Spain) municipality from the Velle dam to the thermal and recreational area of Outariz (see Figure 1).

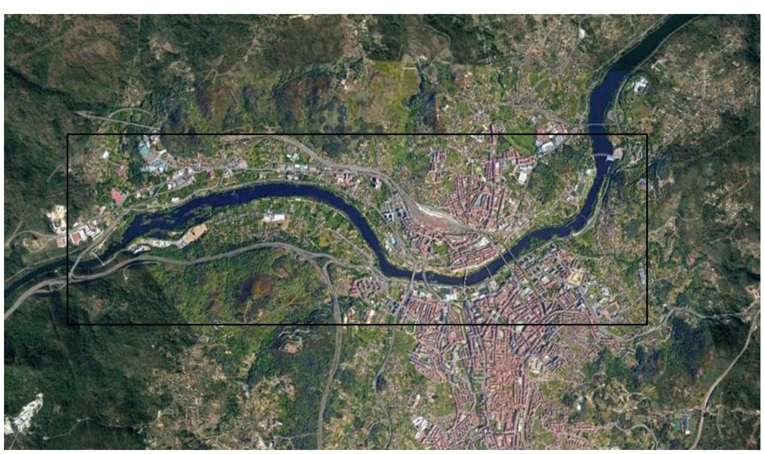

Figure 1 | Ourense location and study area (Miño river)
Source: Google Earth

The Velle reservoir is situated on the head of the examined area. On its normal maximum level (NML), the reservoir occupies an area of 263ha and has a capacity of 17hm3 (iAgua, 2018). Downstream, a stretch of 7.1 kilometres, qualified as a zone of moderate risk (overall risk assessment 2.6 out of 5) (CHMS, 2015), features more than 10 thermal and recreational facilities.

We evaluate the damage of individual elements at risk (micro-scale approach) and employ an empirical approach, which allowed for the collection of precise information, and facilitated the adaptation to the vulnerability of existing situations, i.e. flood type, flooded elements, previous experiences, warning time, etc. The greatest difficulty faced when employing such approach regards the application of the obtained results to other tourist destinations and flood scenarios (Smith, 1994). At the same time, due to the difficulty in obtaining data on the value of affected assets, we employed absolute damage functions, that is, we estimated the direct monetary damage caused by the floods (Messner, 2007). Moreover, as the damage depends on the affected elements' values, considering that such values may increase due to new investments, future periodic calibrations will be necessary (Penning-Rowsell & Green, 2000).

An analysis of damage to the tourism industry has been carried in the first semester of 2016. The study was based on data regarding precipitation levels, the river's water level and average flow, and the floods that affected the examined destination during the data collection period. Additionally, data on tourist arrivals has also been examined, in order to stablish possible connections between periods of high tourist arrival rates with floods and the consequent closing of facilities. Such data was complemented with semi-structured interviews with local government representatives and the manager of the company responsible for the thermal facilities. The analysis of the collected data allowed for the evaluation of strategies adopted by the affected businesses, prevention policies and maintenance actions carried out by the responsible organizations, and coordination mechanisms developed by the various institutions involved.

3.1. Elements a risk

Ourense is promoted as "provincia termal", as the province features thermal pools, spas, sports and recreational areas, and mineral-medicinal springs, all located on the banks of Miño river. There are more than 70 hot springs registered in the municipality, gushing more than 3 million litres of thermal water per day (EHTTA, 2018). Many of those springs are currently exploited, and host infrastructures such as public pools and thermal stations under private concession. Except for one spring, all the thermal facilities are located on the river's north bank (see Table 3). There is a train tour departing from Ourense's old town, which features a 12th century cathedral, to the thermal facility. Along the way, the tour also includes the roman bridge, which was originally built in the 1st century A.D., and is still in use. During summer, 9 tours are done daily, but the frequency drops do 4 a day in winter.

Floods have not directly affected hotels, as those are outside the flood zone. Some spas' restaurants, however, did have to be closed for some days, which significantly affected the operation of these facilities. Chavasqueira spa's restaurant spent 5 days closed, from 2/14 to 2/19; and Outariz spa' closed for 11 days, from 02/14 to 02/25. Regarding the latter, the main reason for the duration of the shutdown is the flooding of the engine room. Outariz Spa has 83 pumps, therefore, it takes longer to repair. This is only the second time these two spas close due to floods in 15 years, the first being in February 2009. However, the pools flood every year, as they are closer from the river and less protected.

Table 3 | Facilities that are susceptible to floods

Impact parameters	Description
Duration of inundation	Direct and indirect damage to the tourism industry in the affected area are directly proportional to the duration of the flood.
Inundation depth	The likeliness of damage to assets and property is directly proportional to the inundation depth.
Frequency of inundation	The frequency of flood events may have negative effects on destination image. On the other hand, the destination improves its capacity to face future floods, as flood experience may also be considered a resistance parameter.
Timing	The time of the year in which a flood event happens influences the magnitude of the damage. Floods during the high season and vacation time affect a higher number of tourists and cause greater business loss.
Resistance parameters	**Description**
Use and type of building	State/level of preparation. For example, a flood in a recreation area with a pool presents lower damage potential than one at a restaurant.
Precaution/ Mitigation measures	Measures that may significantly mitigate the damage caused by the flood, such as construction of dikes and transportation of elements at risk to higher altitude areas.
Early warnings	With enough warning time, the mitigation measures may be particularly effective, as the water levels are still low.

Source: Concellería de termalismo (2017)

3.2. Type of damage

The floods within the examined section of the river are normally of the same type: fluvial floods. Therefore, the damage caused by flood impacts has been relatively homogeneous, which facilitates the evaluation of socioeconomic damage (Kreibich & Dimitrova, 2010). Thermal facilities are open to residents and tourists throughout the year, which helps to fight seasonality, a common problem in the tourism industry. The pools and swimming areas of Oira, however, closes during winter. Therefore, the only costs caused by flood damage are those of cleaning and services repairing. In this context, the city hall has spent 22,547 euros to repair thermal baths and recreational areas, 15,000 € to recover access roads, and 24,623 € in 2016 to rebuild slopes (Araujo, personal communication, February 9, 2017). In previous years, those costs reached much higher values: 300,000 € in 2010, and 600,000 € in 2011 (Rapela et al., 2015).

The floods normally happen in winter, in a period that coincides with two important holidays for the local tourist activity (carnival and Easter). The negative effect on tourist arrivals has been moderate and of short duration. During the flood period (January-March, 2016) there were 46,456 overnight stays in the city, from which 4,231 were from foreigner tourists (INE, 2017). These figures are similar to those from previous years. The only variations are caused by Easter being in either March or April.

3.3. Damage influencing factors

The total precipitation in the examined river section during the first semester of 2016 is 679.9 mm, according to CHMS (2017), and 763 mm, according to MeteoGalicia (2017). The first trimester included the heaviest rain events and had a total precipitation of 457mm and 509mm, according to the same sources (which represents 67% of the total precipitation for the semester). Below are the main damage influencing factors for the case study, differentiating impact and resistance parameters (Table 4).

Table 4 | Impact parameters

Duration of inundation	In January 2016, two flood periods were registered: 01/06 to 01/11 and 02/14 to 02/20.
Inundation depth	The river's average daily water level during the first semester was 2.81m (CHMS, 2017). On January 10th, when the highest precipitation in the semester was registered (44.7mm), the water level reached 6.57m. On January 11th, the average flow was slightly short from 2.000 square meters per second, and slowly decreased during the next days (CHMS, 2017). The heavy rain that occurred between 02/12 and 02/14, combined with that from previous days, resulted in significant floods along the examined section. From 02/11 to 02/19, the average water level descended in 4.13m. The annual maximum (7.27m) was registered on 02/15. The flow during 02/13 and 02/15 was higher than 2,500 square meters per second (CHMS, 2017).
Frequency of inundation	The examined section is classified as area with potential significant flood risk (APSFR). 34 historical floods have been registered in the area, and they normally occur between October and March, especially in December (13 floods since 1909) (CHMS, 2011).
Timing	The two floods of the first semester of 2016 happened around holidays, namely Epiphany (01/06) and Shrove Tuesday (02/09). Those dates are important for the local tourism calendar. The most serious moments of the February flood happened right after the end of Carnival, in 02/10 (Ash Wednesday), therefore, their impact on tourism was less intense.
Resistance parameters	
Use and type of building	Floods affect mainly thermal and swimming pools, which are simple to clean and repair. Occasionally, spas' engine rooms are also flooded.
Precaution/ Mitigation measures	Transferring elements at risk from the flood level zones to higher areas is not always possible, as the tourism and leisure resources are often directly linked to their geographical location (e.g.: geothermal sources). Therefore, relocation would imply a significant loss of attractiveness.
Early warnings	In the case of Ourense, reliable meteorological information is indeed available; however, inundations are often caused by the opening of the upstream dam's floodgates. Several local governmental institutions and authorities of the river basin organism work together, both in the implementation of preventive measures, and in the warning phase, as well as in the subsequent repair actions.
Flood experience	Prior to the floods, maintenance works are carried out in green areas, access roads, and thermal facilities. Cleaning tasks authorized by the basin organization are also carried out on the banks of the river, aiming at facilitating its natural flow. Once a flood threat is detected, technicians from the Velle dam send a discharge increase warning to *Civil Protection*, which is responsible for evacuating the inflow zones. Such communication is also coordinated by the basin organization. Finally, once the flood has happened, repairing measures are carried out (Araujo, 2017).

4. Conclusion

Floods affect recreational areas and thermal facilities located on Miño river's banks, temporarily preventing their use. The constant need for repairing actions in the examined area represents a weakness of Ourense's tourism sector. The constant floods imply the interruption of many tourism-related businesses in the affected areas during the following months. In this context, the goal of mitigating seasonality in the tourism sector by attracting more visitors during times other than the holidays becomes very difficult to achieve. The damage is concentrated in the zones directly affected by the floods. In this context, neighbouring destinations might be benefitted by the temporary unavailability of such areas for tourist use, as well as by the consequent damage to their image caused by an increased perception of risk. The main damages are caused by structural deficiencies (ECLAC, 2003). Tourism's dependency on natural, thermal resources, combined with the fact that such attractions are irremediably located on flood zones, increases the sector's vulnerability to inundations.

In terms of communication, providing precise and accessible information on the affected facilities is essential. The media and local policy makers must distinguish the affected resources, as they differ significantly in relevance. In the examined case, potential tourists perceived the area as being totally flooded, however, only the pools are periodically inundated. On the other hand, the spas, which are significantly more relevant to tourism, are rarely affected. The generic use of the term "flooding of the thermal facilities" is imprecise and causes an overestimation of the damages. As a result, it leads to a negative perception from potential visitors, and thus, negatively affects tourism-related businesses, such as hotels and restaurants. The main limitation of the present study is the difficulty to directly applying the obtained results to other destinations and inundation scenarios. Such limitation is caused by the scarcity of available data, as well as by differences in the types of flooding, affected resources, and influencing food factors.

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