



# How local water and waterbody meanings shape flood risk perception and risk management preferences

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## Abstract

The sharp end of climate change is being, and will continue to be, experienced at the local and personal scale. How changing patterns of hazards interplay with local landscapes is an important focus of risk management, both in understanding how place-based risk is perceived and in identifying how local populations would like these risks to be managed. In this study we focus on the object of hazard and examine how different meanings associated with water and waterbodies relate to flood risk perception and preferences for flood management strategies. We present analysis of a mixed methods study with survey data ( $n = 707$ ) of residents in four coastal towns in France, South Africa and UK presented alongside an in-depth study of the two French towns (semi-structured interviews  $n = 15$  and document analysis). Our analysis unpacks the significance of relationships between the meaning of water in general, and the meaning of specific water bodies, to flood risk perceptions. Our findings indicate that general water meaning is more reliably related to flood risk perception than specific waterbody meaning, where waterbody meanings are significant for flood risk perception, positive identification with rivers relates to reduced flood risk perception. We also find that the meanings associated with water and waterbodies relate to specific preferences for different types of flood management, including insurance and local taxation. The implications for landscapes undergoing rapid change, for example as a result of changing climate and hydrological regimes, are discussed. In particular, we highlight how infrastructure interacts with sense of place in communities undergoing rapid social–ecological change and how understanding this interplay can help in the design of more fully supported adaptation strategies.

**Keywords** Place meanings · Flood · Risk perception · Flood management · Sense of place · Water meaning

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## Introduction

A changing climate will cause widespread changes to local places, these changes will be driven both by disruptive events such as floods or droughts, and also in societal response to such uncertainty with the development of adaptation infrastructure (Devine-Wright 2013). The sustainable management of such changing landscapes and associated hazards requires engagement with a range of stakeholders with varying vested interests and capacities. For successful collective response to changes associated with risks and hazards, we need to look beyond technological and financial constraints on adaptation and also consider also the social limits to adaptation (Adger et al. 2009; Berkes and Ross 2013). To this end, sense of place has been demonstrated to shape motivation and attitudes in adaptation processes potentially providing an avenue to generate consensus

building in managing stressed landscapes (Chapin et al. 2012; Masterson et al. 2017).

Rivers are one of the most managed landscapes globally (Verbrugge and van den Born 2018), pressures such as urbanisation alongside a changing climate means that communities living alongside rivers, and authorities charged with managing them, have a multitude of uncertainties to engage with and respond to. Incorporating the multiple perspectives of invested stakeholders into planning responses to such changes is a significant challenge for river management (Davenport and Anderson 2005; Verbrugge and van den Born 2018). Here we argue for the need focus on the role that key landscape features, such as rivers, play in people's everyday lives, and to consider the meanings that local residents hold for local waterbodies, as they can shape perceptions of risks associated with this landscape, and their preferences for the types of management they are likely to support.

Individuals, communities and environmental managers can behold the same landscape but assign very different meanings to what they are looking at (Köpsel et al. 2017; Stedman 2016). Depending on the person, a river can hold a recreational meaning, be a useful access route for trade or a source of spiritual respite. As a result any changes in landscapes affect people differently depending on how congruent or incongruent the changes are with the meanings that individuals hold. A new jetty to encourage access to a river for boat owners will be greeted differently by someone who has a spiritual association with a river relative to an individual who is interested in recreation. Incongruence between place meanings and changes to places can be distressing psychologically and can motivate place protective action if distressing enough (Devine-Wright 2009; Jacquet and Stedman 2014). In this study we are interested in particular in the meanings that people assign to objects of hazard, and how this shapes perceptions of associated risk. Ultimately, plans that manage to reflect the values that communities hold for local places are more likely to be supported and engaged with. A place meanings lens has been put forward as particularly fruitful in understanding variability in preferences for managing place-based change processes (Stedman 2016), however, there a limited number of studies that systematically analyse the role of meanings and their relationship with risk perception and management preferences.

In this paper we present a multi-method international study of four towns in coastal regions in France, South Africa and the UK, to explore how the meanings attributed to water and waterbodies by local residents shapes their perception of flood risk and preferences for flood risk management. We review existing literature on place meanings, hazards and risk perceptions and consider their implications for social and environmental change. Drawing on quantitative data from across the four towns ( $n = 707$ ) and qualitative

analyses from the two French towns of Lattes and Sommières we examine how water meaning and waterbody meaning relate to (i) flood risk perception and (ii) flood risk management preferences and we explore how place meanings are iteratively created by the public and public authorities.

## Place meanings in changing landscapes

Sense of place is often an overarching term for a number of concepts and in social–psychological place research, sense of place is usually studied by measuring place attachment and/or place meaning (Masterson et al. 2017). Place attachments are often measured in terms of strength of attachment—how connected one feels to a house, town, local area—essentially evaluative judgements along the lines of important/unimportant (Stedman 2016). Place meanings differ from place attachments in that they are descriptive elements of a place—essentially what it is about a place that is significant to people, rather than the strength of peoples' attachment to a place and can include positive (e.g. home, safe and beautiful) and negative (e.g. fear, pollution and destruction) connotations (Brehm et al. 2013). The symbolic meaning of place is not captured in such measures, as such people can change the meanings they assign to a place—from recreational to social—but the strength of attachment can remain constant (Stedman 2003). Whilst knowing the strength of attachments that individuals within a community have with their local area can be revealing, a uniformly strongly attached community may disguise very different place meanings—people within a population may feel that their town is traditional/beautiful/diverse/convenient. Such variations in meaning can explain differences in preferences for future change in a town, variation that would be difficult to discern by measuring strength of attachment. Importantly, such meanings have implications for reasoning, environmental concerns and behavioural choices (Greider and Garkovich 1994; Brehm et al. 2013). Given the explanatory power of place meanings in preferences for place change, in the context of changing social and ecological process they offer a useful entry point for understanding the diverse subjective experiences that people have of change in their local places (Stedman 2016).

## Attachment to hazardous landscapes

Whilst place research often concentrates at the scale of the neighbourhood or settlement, a small number of studies focus on specific features within a place such as a trail, river or a lake (Jorgensen and Stedman 2001; Moore and Scott 2003; Davenport and Anderson 2005; Brehm et al. 2013; Verbrugge and van den Born 2018). In place research relating to natural hazards (See Bonaiuto et al. 2016 for a thorough review) most studies focus on the place at risk—it

is the meaning of, or attachment to, a settlement or home under threat that is examined. Less frequently, the study of meaning or attachment is the object of hazard—be it a river, the sea or a volcano. Whilst natural landscape features are often associated with positive meanings (Ulrich 1993), in the context of natural hazards they introduce something of a dilemma as people are attracted or attached to something that is also a source of danger (Bonaiuto et al. 2016). The well noted restorative aspects of rivers and waterbodies are coupled with risks; ‘wild’ and ‘natural’ can have both positive and negative connotations depending on whether one is referring to aesthetic or flood related dynamics of a river. Given the proximity seeking behaviour that develops as a result of sense of place (Mazumdar and Mazumdar 1993), focussing on specific landscape features can deepen understanding of risk management decision making for individuals that persist in living in hazardous areas.

Place research in hazardous landscapes has demonstrated that how people relate to such places can mediate perception of associated risks. A study of volcanoes in central Java (Lavigne et al. 2008) found that the association of the local populations (both economic and cultural) to the volcanic environment shaped decisions to live in hazardous areas. Similarly, work by Donovan et al. 2012 on sense of place and risk in communities next to an Indonesian volcano found that meanings associated with the symbolic power of the volcano and belief in spirit related stories was related to low risk awareness and reduced propensity to evacuate. As highlighted by Bonaiuto et al. (2016) in the case of some natural hazards there is a tension between self-protection and connectedness goals with respect to valued places. Why do people persist in living in dangerous places?

Unpacking emotional and symbolic relationships with place provides an opportunity to explore the place-based emotional elements of risk perception. Risk is a measure of an event’s likelihood of happening during a certain time frame (Bonaiuto et al. 2016), and relates to something of value—if we don’t value an object or person, potential changes in its state will not be perceived as a risk (Billig, 2006). As outlined by Slovic et al. (2004), risk perceptions are often the product of two processes—an analytical pathway involving calculations of probabilities that takes some time, and an emotional process that is more instinctive and immediate. Risk research has revealed a number of decision-making biases, and Bonaiuto et al. (2016) describe a number of these in relationship to environmental risks. In particular, Bonaiuto et al. discuss the well-tested optimism bias—the belief that bad things are unlikely to happen to you, a finding repeated in studies of environmental hazards. Whilst a barrier to protective decision making, this bias does protect emotional resources and wellbeing on a daily basis, as attachments to valued people and things can be maintained without acute concern for safety. These emotional

aspects and potential biases of risk perception can result in reduced risk perception in situations where objective risk levels remain high.

### Managing a plurality of place meanings

In this study we focus specifically on waterbody meanings and associated flood risk and management. The meanings that people assign to bodies of water and their hinterlands shape their concern for changing watersheds and their preferences for waterside development and management (Davenport and Anderson 2005; Brehm et al. 2013; Verbrugge and van den Born 2018). In Davenport and Anderson’s qualitative study of riverside development, they found that construction was not opposed uniformly by local residents, support was determined by whether construction reflected the values that people held for the river. There were four main groups of river meanings identified in their study: tonic (river as respite); sustenance (river as source of finite services); nature (ecology and undisturbed); and identity (tied to sense of who one is). Interestingly, respondents assigning nature meanings were least likely to discuss negative impacts of building development. In this instance, an activity that would appear to be in direct contradiction to place meaning—hard infrastructure installed in a place valued for nature—was not experienced as particularly jarring by individuals that assigned nature meanings. Once developments alongside waterbody shorelines do occur the symbolic base of attachment can change for local populations, from places of ‘escape’ to ‘social’ places (Stedman, 2003). Management of meanings does not in this instance only refer to variability amongst local residents, work by Köpsel et al. (2017) on environmental management in Cornwall, England describes how different meanings assigned to landscapes by key actors in landscape management shape perceptions of change and subsequent preferences for management choices (Köpsel et al. 2017). The range of actors involved in river landscape management makes collaboration a difficult but necessary process for sustainable development and so making explicit the meanings that people attach to places can facilitate inclusivity in planning for potential place changes (Brehm et al. 2013; Plieninger et al. 2018).

In fast changing social–ecological systems there is the possibility that place meanings may act as fast or slow variables in shaping subjective perceptions of change and subsequent behaviours (Stedman 2016). For Masterson et al. (2017) meanings can act as “slow” variables in the system that creates a time lag preventing timely action to respond to or prepare for changes. In other situations, particularly in times of high social mobility and change, place meanings may act as a fast variable in a system as new actors precipitate a shift in meanings that has implications for ecosystem management. The dynamics of place meanings are driven

both by the interactions among heterogeneous actors that hold different meanings, and by policies and management decisions (Köpsel et al. 2017). Through the implementation of policies and infrastructure, environmental management authorities change the assets of a place and shape how it is experienced by local communities leading to an evolution of place meaning (Stedman, 2003). Conversely, place meanings manifest in resident discourses about how their place should be managed and elected representatives and managers take into account discourses and controversies about place in their decision making. The feedbacks between these two processes can lead to a strengthening of a given place meaning contributing to the persistence of the state of the system, on the contrary, can precipitate the emergence of new place meanings and potential for the transformation of the system.

The processes of co-construction of place meanings between local communities and management authorities have implications for risk management in shared landscapes and are currently an understudied phenomenon. The power of public bodies to change places that are meaningful for the public demands a consideration by researchers of organisational drivers of place change as well as resident and user perceptions. Here we use the example of waterbody meanings and related perceptions of risk and management preferences to explore how multiple meanings can be managed in dynamic social and ecological landscapes.

## Methods

The methodology adopted is a mixed methods approach combining a survey across four towns yielding quantitative data, and a series of interviews in two of the town which produced qualitative data. The quantitative analysis enables us to explore the range of water and waterbody meanings in different contexts, and the qualitative analysis provides rich insights to link these with risk perceptions and interrogate causal relationships. This collaborative, multi-method strategy represents best practice mixed methods research to analyse complex human-environment interactions as advocated for example by Poteete et al (2010) amongst others in sustainability science.

## Study areas

The four towns in this study (two in France, one in South Africa, one in the UK) are sites within the study areas of an international project on adaptation to global change in coastal areas.<sup>1</sup> The four towns are all exposed to flood risk

(two are solely fluvial, and two towns experience both fluvial and tidal risks) as well as experiencing broader social and ecological change (See Table 1 for further details on the context for each town) (Fig. 1).

Wadebridge is located in southwest England in the peninsular county of Cornwall, it has grown up on the river Camel and flood risk is associated with winter storms generated by low pressure systems over the Atlantic and intense heavy rainfall episodes in the summer (Faulkner et al. 2018). The town is a growing increasingly popular with second home owners but still largely retains the characteristics of a market town, Wilderness is located on South Africa's Western Cape in the tourist region of the Garden Route. This area is associated with outstanding natural beauty and is attractive to tourists and second home owners alike. Flood risk in Wilderness is associated with both the river that is sometimes impeded by sediment build up at the mouth, as well as the threat of sea surge and dune erosion for houses on the sea front. In France, Sommières and Lattes are located in the southern coastal region of the Languedoc. Whilst the two towns had similar flood risks and regimes 50 years ago, Lattes has developed significant infrastructure to manage flood risk to allow urban expansion whilst in Sommières flood risk management is softer. Sommières retains much of its characteristics as a country market town with a diverse population attracted by relatively cheap rents, whereas Lattes, closer to Montpellier, has a more homogenous population of middle class residents attracted by the good services and proximity to the city.

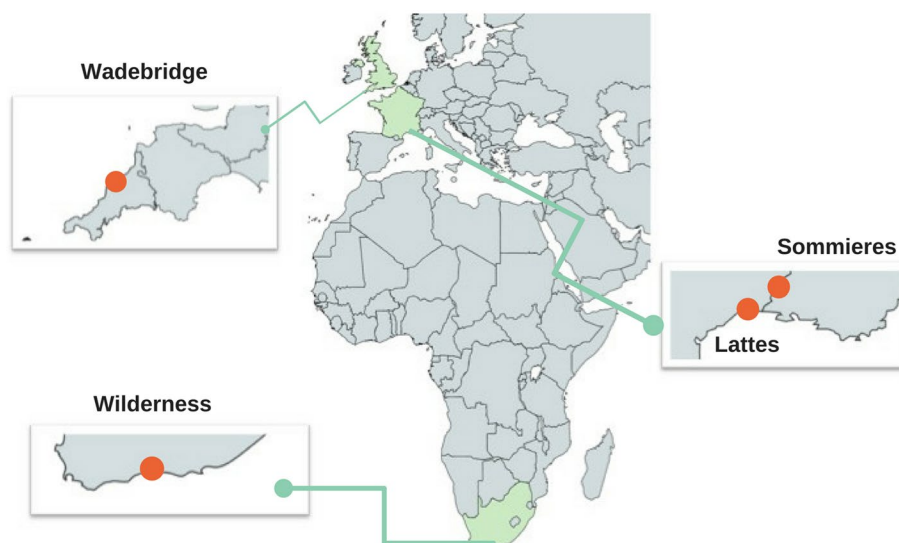
All the towns experience varying levels of flood risk, with flood management plans in place across the sites. In Lattes this has resulted in extensive flood infrastructure development that has impacted on the trajectory of the town (expanded on below in the tale of two cities), similarly in Wadebridge flood risk has been managed by the development of extensive flood walls and sluice gates. On the contrary, in Sommières and Wilderness hard infrastructure is less of a feature. In Wilderness, limited funds as well as being a town identified with natural beauty means that the approach for risk management largely centres on dredging the channels rather than hard infrastructure. Similarly, in Sommières risk management centres on catchment management and warning systems. In Sommières in particular, the approach to flood risk is softer, with extensive warning systems and people in the flood zone living in a way that prepares them to move furniture upstairs in their property at short notice.

<sup>1</sup> <https://www.researchgate.net/project/Multi-scale-Adaptations-to-Global-change-In-Coastlines-MAGIC>.

**Table 1** Socio-economic and flood risk context for the four towns of Lattes, Sommières, Wilderness and Wadebridge

	Lattes	Sommières	Wilderness	Wadebridge
Social and economic context of town	20,000 inhabitants. Between the city of Montpellier and the sea, has grown very fast during the last decades. Has attracted wealthy residents (retirees, entrepreneurs and skilled employees). Close to the airport, train station, and highways	5000 inhabitants. Constructed around a Roman bridge on the river, used to be rich and industrial but contains now a poor population, or wealthier people composed of retirees or people commuting to the cities around	6000 inhabitants, established itself as an attractive seaside town. Trend towards immigration by retirees and second homeowners. The lakes and the Touw River in Wilderness have been under formal protection since 1968, and now form part of the Garden Route National Park. The main industry is tourism, the Touw River providing a popular destination for canoeing, camping and birding	Wadebridge grew up around the river Camel that runs through it, and until the mid 20 <sup>th</sup> century was a small market town. Now its main industry is tourism with high numbers of summer visitors and an increasing number of second home owners and retirees moving to the area There are five sites of SSI along the camel trail
River system	One big and several smalls Mediterranean rivers prone to severe flash floods in the autumn	A Mediterranean river prone to severe flash floods in the autumn	Wilderness is situated where the Touw River connects to the Indian Ocean. Water runs off the Outeniqua mountains to the ocean and lakes via small catchments. The river has a temporary open/closed estuary, with a river mouth periodically opening to the sea when stream flow is high after heavy rains	North coast of Cornwall, River in Wadebridge is tidal. Flood risk occurs in association with winter storms and high tides, and in the summer following intense rainfall episodes
Type of flood defences	Dykes constructed between 1980 and today with a high expense in infra-structures in the early 2000	No dykes. Retention dams upstream. Alarm systems. Individual adaptations (living on the first floor)	Artificial mechanic breaching of the estuary mouth (small trench is opened with a bulldozer) when the level of the estuary reaches a predetermined threshold. No major public infrastructure to protect from sea surge but some property owners exposed sea surges have used gabions to prevent dune erosion	There are flood walls in the centre of town, a dike to hold back floodwater. Upstream to the town there are over-flow ponds
Flood risk	Under control unless exceptional rains in addition to flash floods	Very high. Floods occur every year. Major Floods in 1958 and 2003	Flood risk only after exceptional rains and untimely breaching of the river mouth	Flooding occurs regularly on the edge of the town but the risk is low in the centre of the town

**Fig. 1** Location of the four study towns: Lattes (France), Sommières (France), Wilderness (South Africa) and Wadebridge (UK)



### Data collection and sample

The research process for this project centred on face-to-face quantitative surveys that were conducted in 2016 in each of the four towns. An extensive pilot study ( $n = 70$ ) was conducted in the two French towns in 2015 that resulted in editing of questions so that item meanings in the large scale survey were comparable across countries (See Quinn et al. 2018 for details). The first part of the survey focused on place attachment, place meaning and general risk in the towns (social, environmental and development) and the second half more specifically on flood risk perceptions and support for flood risk management. The main survey took 30 min on an average to conduct and sampling was stratified so that half of respondents were in flooded risk areas according to local flood risk maps and half were non-exposed populations within in each town (as Adger et al. 2013). Both exposed and non-exposed householders were included as decisions for flood risk management are informed by, and impact, residents from both areas.

In the French study area there was a multi-stage research process, first with the pilot study in 2015 and then main survey in 2016. This series of surveys were carried out in parallel with semi-structured interviews with individuals ( $n = 15$ ) that have direct experience and responsibility in flood risk management, alongside analysis of public documents pertaining to flood risk (reports and public documents from public organisation at the watershed level such as <https://sommieres.fr/ppri-365200-1-4-52.php>, and <http://www.ville-lattes.fr/plan-de-prevention-des-risques-dinondation/>). The wider research project in France focused on the social context and historical trajectories of the towns of Sommières and Lattes, the history and politics of infrastructure

development and the framing of adaptation measures in local and national policies.

### Place meaning measures for water and waterbodies

Place meaning for waterbodies was captured using a word association task as per Devine-Wright and Howes (2010). Respondents were asked what the first three words or phrases that came to mind to describe the meaning of their local waterbodies. In the three towns of Wadebridge, Sommières and Lattes the waterbody is the river that runs through the town. In Wilderness waterbody refers to the river (or estuary), the lakes or the ocean (35%, 30%, 35%, respectively).

In the 2015 pilot study, respondents in Lattes, which has extensive flood risk management infrastructure indicated that the river Lez held no meaning for them, however, they did mention issues of flood water in their town. In this specific instance, people did not associate flooding with river water. As a result, two questions were developed to capture how people relate to water in their local area. The first asked about the general meanings people assigned to water in their area that included items such as rain, expense and drought; and the second asked about specific waterbody meanings. The final themes that emerged from the coding framework are described with examples in Table 2. Three researchers inductively developed six codes to reflect the waterbody meaning (positive relational, positive service, structural, nature, dangerous and not maintained). As water meanings included diverse themes such as drought, flood, plentiful the final coding framework was necessarily quite broad and assigned positive, negative, dual or neutral meanings to water. Dual meaning reflects responses that included both positive and negative orientations to water in the local area.

**Table 2** Coding framework for water and waterbody meanings

Place meaning	Thematic code	Description of code where necessary and examples
Water meaning	Positive	Plentiful, precious, clean
	Negative	Dangerous, dirty, drought
	Neutral	No normative orientation given e.g. it is a river
	Dual	The respondent gave both a positive and negative meaning
Waterbody meaning	Positive relational	A strong personal relationship with the waterbody—possibly anthropomorphised, e.g. it's central to this town, I grew up watching it
	Positive service	A utilitarian relationship, both aesthetically and functionally—calming, pleasant, leisure
	Structural	Geographical and neutral references—e.g. it is there, it is an estuary
	Nature	References to abundance of wildlife, flora and fauna
	Danger	Flooding, drowning
	Not maintained	Dirty, not maintained

### Flood risk perception measures across scales

Perceptions of flood risk were captured at two scales, town and property. Perceived exposure was captured using items with Likert scale responses to items focusing on exposure to risk (Similar to O'Neill et al. 2016) with a focus on exposure to risk (Arias et al. 2017). Respondents were asked to rate the exposure of their property and town to flood risk on a scale of 1–5 (1 being absence of exposure and 5 being high exposure).

### Flood risk management preferences

Respondents were asked on a scale on a 5-point-Likert scale whether they would support various options for flood risk management in their town ranging from strongly agree (5) to strongly disagree (1). In the UK and South Africa, the options were planning law changes, managing retreat/set-back lines, a local tax for defences, restore ecological infrastructure, and build more hard infrastructure.

In France, where recent floods in 2002 have politicised potential flood management options, the river management options were more context specific, however, several items pertain to the same categories as operationalized in the UK and South African surveys. An item for hard infrastructure was included, and ecological infrastructure was captured with a specific question on setting aside agricultural land upstream in the catchment. For a financial management option, a question was asked about willingness to take personal insurance. For a legislative management option, an item about the commitment of elected people was included.

### Analysis

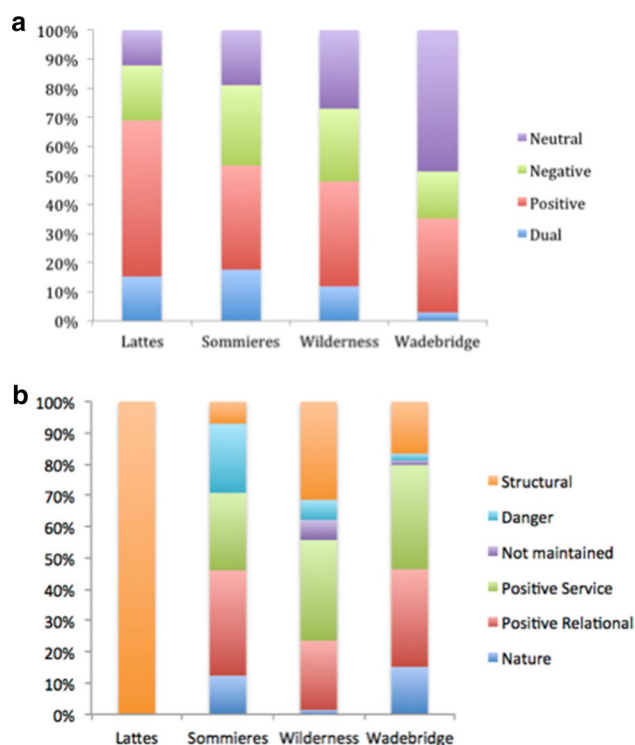
We used the R software to run ANOVA on our Likert scale data (Norman 2010) (`lm {stats}`) to test the relationship

between the perception of flood risk exposure at property and town scale and water and waterbody meaning. As for our previous study we also tested the effect of objective exposure on flood risk perception. ANOVAs were also used to test the effect of water and waterbody meanings on flood risk management preference (again five possible scores).

## Results

### Water and waterbody meanings

Across the four towns there are varied meanings assigned to water in the local area. The descriptions of water cover a broad range of meanings including clean, cheap, expensive, and drought alongside risk related terms such as danger, not maintained, and flooding. In Wadebridge the dominant groups of meanings are neutral, however, in the other towns positive meanings are most frequently given. When the scale of meaning is narrowed to waterbodies—which mostly refers to rivers in the towns—the qualitative nature of meanings change. Most significantly in Lattes the river Lez is ascribed a structural meaning by all respondents—this category is made up of responses such as 'there is a river' or 'it runs to the sea'. In contrast, 38% of Sommières respondents ascribe a relational meaning and 28% a positive service meaning. This is a town where residents identify strongly with the river that runs through it. In both Wilderness and Wadebridge positive relational and positive service meanings account for over 50% of responses. Danger and not maintained responses are most numerous in Wilderness (18%), whilst these towns all experience flood risk, this threat is not widely reflected in the waterbody meanings that residents provide (Fig. 2).



**Fig. 2** Water meanings and waterbody meanings across Lattes, Sommières, Wilderness and Wadebridge. **a** The percentage of respondents that described water in their towns with neutral, negative, positive or dual meaning. **b** The percentage of respondents that described the waterbody in their town with either a structural, danger, not maintained, positive service, positive relational or nature meaning

### Water and waterbody meanings and perceptions of flood risk

Over 50% of respondents previously experienced flooding in their town, with 88% of respondents in Sommières and 70% of respondents in Lattes having had direct experience of a flood event. In Wilderness 65% of respondents had experienced a flood and in Wadebridge less than half of respondents (35%) have experienced flooding. We tested at the outset whether exposure (living in demarcated flood zones) predicted risk perception at the town scale and found that objective exposure is strongly correlated with flood risk perception for 3 of the towns at property scale, but was never related to perceived flood exposure at town scale. Further,

objective exposure positively correlates to risk perception in Sommières and Wilderness ( $F = 7.18$ ,  $p < 0.01$ ,  $\text{coeff} = 0.32$  and  $F = 16.35$ ,  $p < 0.01$  and  $\text{coeff} = 0.33$ , respectively) but negatively in Lattes ( $F = 14.99$ ,  $p < 0.01$ ,  $\text{coeff} = -0.27$ ).

We then focused on the role of water and waterbody meanings, and correlational analysis of water and waterbody meaning and perception of flood risk at the town scale demonstrates a difference between how these two sets of meanings relate to risk perception (See Table 3). Water meaning relates significantly in the four towns to flood risk perception and only in one town (Sommières) does waterbody meaning relate to risk perception. Taking the Neutral type of water meaning as the intercept, we looked at the meanings that are significantly different to Neutral. We find that Dual and Positive types of water meaning are significantly different to Neutral. In three towns (Sommières, Wilderness, Wadebridge), those who hold a dual or positive meaning for water are less likely to perceive flood risk than those who hold a neutral meaning, although in Lattes it is the opposite. To analyse waterbody meaning we select Structural meaning as the intercept. Here we find less significant results. However, in Sommières, when residents hold a positive service or relational meaning for their river, they are less likely to perceive flood risk than residents that hold a Structural meaning (see supplementary materials—S1—for more details). Positive service or relational meanings reflect identification with the river and an association with pleasant and calming characteristics. In Sommières, the town where flooding is part of the town's identity and 88% of respondents had experienced a flood, a positive meaning associated with the river is related to reduced risk perception, and those holding structural meanings (e.g. it is a river/estuary) perceive relatively higher risks. Interestingly, across the four towns the relationship between water and waterbody meaning and flood risk perception is not significant at the property scale—it is at the town scale that perception of risk relates to symbolic meaning of these landscape features.

### Water and waterbody meaning and flood risk management preferences

Correlational analysis between water and waterbody meanings with preferences for river management reveals

**Table 3** The relationship between water and waterbody meaning with perception of exposure to flood risk at the town scale

Exposure town	Lattes	Sommières	Wilderness	Wadebridge
Water meaning	$p = 0.018^*$ , dual perceive more than neutral	$p = 0.099$ , dual and positive perceive less than neutral	$p = 0.009^{**}$ , positive perceive less than neutral	$p = 0.039^*$ , dual perceive less than neutral
Waterbody meaning	NS	$p = 0.027^*$ , positive relational and positive service perceive less than structural	NS	NS

\* $p < 0.05$ ; \*\* $p < 0.01$



**Table 4** Significant relationships between water and waterbody meaning and support for river management options

Place variable	Lattes	Sommières	Wilderness	Wadebridge
Water meaning (negative, neutral, positive, dual) Intercept = neutral	$p = 0.001^{***}$ Positive is positively correlated with support for insurance	Not significant	$p = 0.056$ Negative is positively correlated with support for ecological infrastructure	$p = 0.068$ Negative is negatively correlated with support for tax
Waterbody meaning (structural, danger, not maintained, nature, positive relational, positive service) Intercept = structural	Not significant	$p = 0.072$ Danger is positively correlated with support for hard infrastructure	Not significant	$p = 0.041^*$ Positive service and positive relational are positively correlated with support for tax $p = 0.03321^*$ Not maintained is positively correlated with support for law

\* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$

differences in how the meaning of the two objects (water and waterbody) relates to preferences for management. Table 4 presents the results of the regressions between management options (tax or insurance, laws or political action, ecological infrastructure, hard infrastructure, retreat). In Sommières and Wilderness, which are the two towns where water is not managed by significant hard infrastructure, we see correlations between infrastructure management option and a negative perception of water (Wilderness) or the waterbody (Sommières). More details on these relationships can be found in supplementary material (S2). In Wadebridge we find a complicated story for meaning and risk perception. Here, negative water meaning is negatively related to a local tax for river management. If one holds a negative meaning for water, one is more likely to support the imposition of a tax for flood risk management. However, in the same town a positive perception of the waterbody, the river Camel, either a service or a relational dimension, is positively related to the tax management option (See S2c for more details). In Wadebridge we also see that a not maintained perception of the waterbody correlates with a law management preference, however, only three residents hold this meaning. Similar to Wadebridge residents with a positive water meaning, in Lattes (the other town with hard infrastructure in place) positive water meanings are positively related to preference for a financial measure for managing flood risk in their homes.

In summary, the quantitative results generated by the surveys suggest a significant difference between how waterbody and general water meanings relate to risk perception. Water meaning is always related to flood risk perception and a positive water meaning is linked to a reduced perception of risk. If one associates a positive meaning with water, one is less likely to perceive flood risk. Waterbody meaning only linked to flood risk perception for Sommières, and here positive meanings are also associated with a reduced perception of risk. There is a not such a significant

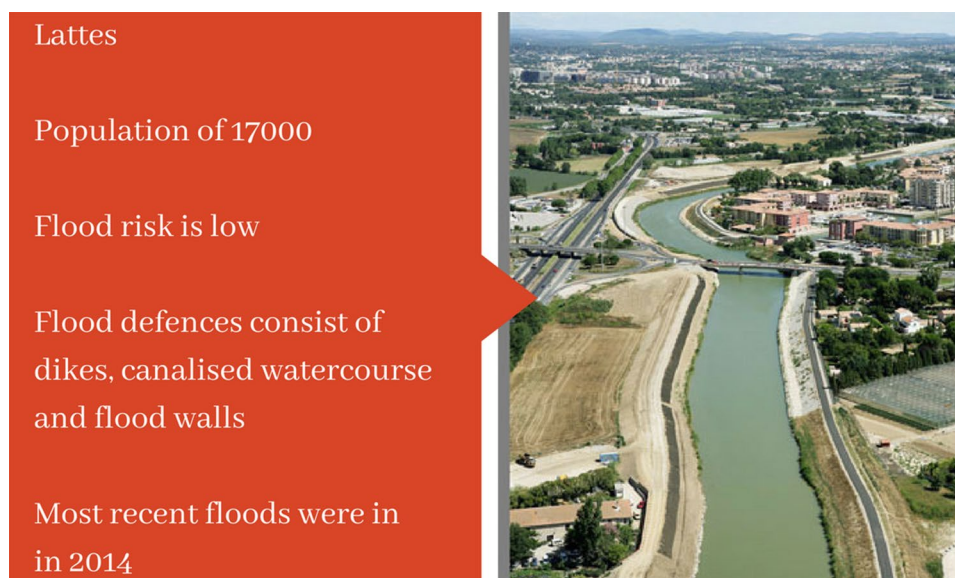
difference between how waterbody and general water meanings relate to flood risk management options. Whether the town has flood risk infrastructure in place seems to play a role, residents of towns with infrastructure (Wadebridge and Lattes) being supportive of tax and insurance while residents of towns without protection infrastructures being oriented to hard and ecological infrastructure management. To explore these differences further, and in particular to investigate how river and water meanings may change over time, we consider the findings from qualitative research undertaken in the French towns of Sommières and Lattes. This data collection, conducted in parallel with the surveys, focuses on the historical relationship between people and water in each town and examines how residents and authorities have iteratively constructed river and water meanings in the process of managing of flood risk.

### A tale of two towns: the relationships between flood risk infrastructure, policy and place meaning

In France the survey was part of a larger, multi-method investigation into adaptation to flood risk in Lattes and Sommières. Over two and a half years the pilot study and full survey were carried out in parallel with semi-structured interviews ( $n = 15$ ) with individuals in local environmental organisations, local historians and local policy makers (elected people selected for their role in risk management, previous elected people holding the same responsibilities) alongside a process of document analysis of local and national flood risk documents (Tabutaud 2015; Sougrati 2015; Chapot 2016; Guy 2016; Sila 2016; Moukomba 2016).

Data gathered from document analysis and interviews suggest that half a century ago the two towns of Lattes and Sommières, approximately 30 km apart in distance were similar in the way they managed autumnal river floods (the hydrological regimes are similar). Lattes was a village of

**Fig. 3** Aerial view of Lattes and flood risk management infrastructure



farmers whose houses were located on elevated locations and for whom the autumn floods were manageable events (Durand 2014). Sommières, a town built partly on the riverbed, has a long history of flooding and residents and authorities had developed adaptive strategies to deal with autumnal floods, such as monitoring the upper watershed, warning systems, rapid transfer of belongings to the upper floors.

### Infrastructure and management trajectories

Lattes became part of the greater urban area of Montpellier in line with urban planning strategy in the 1960s, and national and local government (department and regional) targeted this area for the expansion and settlement of large infrastructure (Chevalier 2014). In contrast, Sommières was not a targeted development area and has developed an identity of a town that “lives with floods”. These different perceptions of the acceptability of floods by public authorities, informed by prevailing urban planning, has led to different flood adaptation trajectories in the two towns (Figs. 3 and 4).

While policy makers and residents in Sommières continue to accept a “living with risk” approach as they have for centuries, decision makers in Lattes reoriented their management approach towards that of “protection from risk” which started in the late 1980s with investments in costly hard infrastructures (dykes, canals) to protect the population from flood risk. As evident in local flood management documents where the focus of planning moved from coping to flood prevention, floods are no longer an acceptable risk in Lattes. This shift was highlighted by an elected official, development of infrastructure is changing knowledge in risk management, “now in Lattes we have lost this culture of risk. If something happens, no-one is prepared”.

In autumn 2002, a big flood event caused extensive damage in the two towns. Regional planning documents and interviews with technicians from local management bodies reveal that, as a response, Lattes reinforced investment in hard infrastructures, investing further in the dyke system, while authorities in Sommières reinforced a living with floods approach, choosing to improve the alarm system (the roll out of an application on the telephone of each resident for instance) and lobbying by elected officials at the watershed scale for the creation of retention dams upstream to decrease the magnitude of floods in the centre of Sommières (Tabutaud 2015). In Sommières, living with flood risk is to some extent accepted, a local town planner describes this historical relationship: ‘Sommières has always been a flooded town since it was created, water always come back to its place’. In both towns the management strategy is supported by strategic communication campaigns by elected officials promoting opposing messages, “Risk is controlled, you are secure” is the message in Lattes, after a concerted effort described by an elected official “We have communicated a lot about the absence of danger. The more sceptical have changed, now every body is convinced” (Sougrati 2015). In Sommières local authorities promote a culture of living with a risk and that can be responded to quickly through warnings and solidarity—with local shopowners prepared to respond to flood warnings by moving all belongings upstairs, even if the warning arrives during the night (Tabutaud 2015).

### Trajectory of risk perceptions

The local authorities in Sommières have not significantly changed either their management approach or the communication about risk over the past 50 years. The river Vidourle,

**Fig. 4** Signage on wall in central Sommières marking previous flood levels



Sommières

Population of 5000

Flood risk is high

Flood defences consist of retention dams upstream, alarm systems and household scale adaptation e.g. main living space located on the first floor

River floods annually

often personified by residents, floods the city every year and the river's rhythm has been considered a natural event for centuries and is generally accepted as part of Sommières life. For survey respondents in Sommières the river meanings are often positive, either for the relations it enhances or the services it provides (Fig. 2). However, it is important to note that of the responses given approximately 15% of those surveyed in Sommières associated the river with a danger meaning.

Work by Durand (2014) analysed how the river Lez in the town of Lattes has been represented in a local newspaper over 30 years. The analysis is based on articles published between 1978 and 2001 (before the hard infrastructures) and between 2008 and 2010 (after the hard infrastructures) in the local newspaper. Articles in the early period often highlight the knowledge and ancestral know-how of local water management. A common demonstration of this historical relationship is the many anthropomorphisms used to describe with river, sometimes referred to as the grandfather of the family: "Grandfather Ledum" (Durand 2014). This personalised relationship with the river typified in the earlier period of this study contrasts with the apparent paring back of the relationship to the river in recent times. The representations of the river in the local paper become more homogenised and the river Lez becomes an object of leisure. No other representation of the river is listed in the consulted editions during the second period, reflecting a shift in river meaning that is more instrumentalized as a resource for recreation for residents or tourists. With the demographic evolution of the municipality, the forms of investment in the river are evolving, and new place meanings are being created. Newcomers take ownership of the place differently. If the period between 1978 and 2001 was characterised by a diversity in the representation of the river, suggesting a river that was strongly

identified with by residents, the representations of the river in the period between 2008 and 2010 have become simplified resulting in a river with a primarily leisure focused meaning.

The results from our 2016 survey shows that the Lez river no longer holds a leisure meaning for Lattes residents, with 100% of respondents providing a structural meaning in the survey (see Fig. 2). The engineering of the river for reduced flood risk has contributed to a significant shift in new investments and subsequently this has made the town more attractive as a settlement for wealthy newcomers with their own distinct place meanings and relationships with the river (Quinn et al. 2018). Our main survey finds that in Lattes objective exposure in Lattes is negatively correlated with perception of flood risk in the town, and so it seems that the infrastructure has been successful in making the exposed population feel that local flood risk is limited.

## Discussion

In bringing together the survey and qualitative analysis our study makes contributions to the existing body of literature in two ways. First, our results demonstrate important differences in the relationships between water and waterbody meanings and flood risk perceptions and preferences for risk management. Second, we emphasise the socio-political processes involved in shaping the development of water and waterbody meanings over time and the implications that this has for managing flood risk.

## Waterbody meanings and changing perceptions of risk

We find that the difference between general water meaning and specific waterbody meaning is significant for flood risk perception. Residents that assign positive general water meanings are less likely to agree that their town is at risk of flooding. Residents that have a dual perception of water can be more (Lattes) or less (Sommières and Wadebridge) likely to agree that their town was at risk of flooding. The waterbody meanings are a richer set of themes differentiating, for example, between services and relational aspects. Whilst the relationships between waterbody meanings and risk perception are not significant across all the towns, in one town that does not have significant hard flood management infrastructure (Sommières) there is a significant relationship. Here, positive service and positive relational waterbody meanings are significantly related to risk perception: when residents hold these positive meanings they are less likely to perceive flood risk. These findings are consistent with Lavigne et al. (2008) and Donovan et al.'s (2012) qualitative studies of volcanic risk that found positive landscape meanings are associated with lower levels of perceived hazard risk.

The case of dual meaning and flood risk perception is more complex. In Lattes holding a dual meaning increases the risk perception while in Sommières and Wadebridge dual water meaning attenuates risk perception. We have highlighted that only three residents report a dual meaning in Wadebridge and thus will focus on the comparison of Lattes and Sommières, and the sociology and history of the two towns. A potential explanation for this result is that the effect of the dual perception of water meaning (both positive and negative) challenges the local narrative about risk. In Lattes, where the narrative is one of security, residents holding dual meanings are aware of the risk and so recognise the threat from floods despite the prevailing narrative. Conversely, in Sommières where the narrative of flood risk is physically materialised in signage and markings a dual meaning for water counters the perception of risk and so acts in an opposing direction. These are tentative explanations, but we think that the process of people holding multiple (and perhaps emotionally opposing) meanings for place features that emerged in our data collection, can offer rich perspectives in further studies exploring the complex processes that relate sense of place and risk.

The tale of two towns in France considers landscape transformation over time (Verbrugge and van den Born 2018) providing insights into the socio-political processes linking infrastructure development, water and waterbody meaning and risk perception. In Lattes, infrastructure to manage flood risk has completely altered the way the town has developed—indeed the river is difficult to see from the town itself as it is obscured by raised dykes. As a consequence,

the river meanings for the local population are now homogenous and associated with structural descriptions. In Sommières, where authorities and residents have pursued softer flood management options, there are still a variety of river meanings, and relational and service meanings (both with positive connotations) correlate with lower perceptions of risk. However, in Lattes it appears that the perception of flood risk has become disincarnate from the river, as water in general still holds meaning and significantly relates to risk perception. Our findings suggest that infrastructure in certain circumstances can significantly change waterbody meanings and how they shape associated risk perception.

Whether people connect flood risk to rivers in their area or more abstractly to water in their area has implications for flood risk communication. Our focus on the object of hazard reveals that valued features of place can cause a dissonance with risks from that object—and so risk communication documents should reflect this. In particular, where natural features have positive meanings, communication about associated risk could recognise both the positive and negative impacts of living in the locale. For residents in Sommières that have personalised the river, communication about risk could incorporate the more personal meanings that people hold, and messages can be framed reflecting such connotations. In Lattes, while risk seems to have become disincarnate from river meanings, this also reduces the propensity of personalised meanings to inform risk perception. Risk communication in this instance could incorporate more dislocated language around water management in the town. Given that risk perception is informed by emotion as well as analytical considerations, unpacking emotional connections to hazardous landscapes through identifying place meanings can help with targeted risk communication.

## Managing multiple and evolving meanings

This study has implications for the way in which the collective processes of responding to social–ecological change can be managed. Masterson et al. 2017 highlight that place change does not affect populations uniformly, a diversity of meanings amongst a population means that changes will be felt more strongly or weakly depending on how one's place meaning is challenged. Our findings align with and build on previous work by Durand (2014) in the French case study area, we find that flood management developments have changed the relationship between town residents and the river in Lattes where flood risk management has resulted in significant infrastructure. Whilst these changes were primarily motivated to reduce flood risk not all residents were, or are, at risk of flooding but now find that their experience of the river ultimately changed. As favourite places contribute to well-being by enabling people to reconnect with past experiences and memories (Scannell and Gifford

2017), large infrastructure development that significantly alter landscapes impacts the psychological health of local populations (Jacquet and Stedman 2014). This brings to the fore issues of fairness when managing a plurality of meanings—how do you ensure that action to reduce risk or adapting to anticipated risk does not unfairly impact groups of people with distinct meanings for places? As Adger et al. (2013) emphasise place meanings need to be considered for inclusive decision-making processes in climate change decision making, indeed consideration of multiple and shared meaning can help build consensus for managing change processes (Chapin et al. 2012). Methods created to measure and geographically locate place values and meaning seem like fruitful frameworks to aid discussions and planning for large scale and contentious infrastructure development (Davenport and Anderson 2005; Brown and Raymond 2007; Raymond et al. 2009).

This study highlights processes through which place meanings are iteratively produced by public authorities and local residents. The case of Sommières illustrates how a risk management approach and a communal acceptance to “live with floods” is reinforced, and co-exists with an appreciation of nature and relational meanings. The story of Lattes, however, suggests that place meanings can change as a result of hard infrastructure and a policy to control the river. Findings published from the pilot study (Quinn et al. 2018) suggest that this process of place meaning evolution is reinforced by mobility processes in Lattes, with new residents being attracted to the identity of the town as safe and services oriented and so they adopt a neutral meaning for the river. The social negotiation of place meaning in this case is set against the backdrop of risk events, a result of resident’s demand for protection and authorities’ management choices. These findings reflect the iterative and political nature of place meaning construction and shows that focussing on multiple actors in management of SES change can be particularly useful in identifying trajectories in place meaning development (Stedman 2016). It echoes the call by Birkholz et al. (2014) that flood risk research can usefully harness constructivist approaches to investigate flood risk that focus on a wide range of actors, including policy makers and residents who do not live in flood zones.

For flood management preferences there is an interesting difference between the significance of general water meaning and specific waterbody meaning. For two of the four towns, positive water meaning is correlated with support for a financial form of management for flood risk. In Wadebridge where respondents were asked about support for a local tax for flood risk management, negative water meanings were negatively related to this form of management and positive waterbody meanings correlated with support for this form of management. In Lattes, positive water meanings are correlated with willingness to engage in private insurance to manage flood risk. Thus positive meanings relate to a

willingness to engage in financial management practices, similar to findings on place attachment and conservation of natural space (López-Mosquera and Sánchez 2013). A negative or danger meaning for water or waterbody is related to other management options. In Sommières and Wilderness, negative meaning is related to support for hard or ecological infrastructure. Our results indicate that a positive perception of water (bodies) leads to a willingness to invest in “provisions” to cope with the natural hazard (tax, insurance) while a negative perception leads to a requirement for tangible protection. The meanings for water were necessarily broad, given the range of responses relating to cleanliness/taxes/flooding—future research on this relatively dislocated meaning of water could usefully refine water meanings, in particular to give explanatory power as to their relationships with wider perceptions and attitudes.

## Conclusion

This study shows that water and waterbody meanings matter for perceptions of flood risk and preferences for flood risk management. Over time, the relationship between meanings and risk perceptions can change, and large infrastructure development has the potential to disrupt the relationship between river meanings and flood risk. The iterative construction of risk and meaning between residents and authorities means that changes in landscape driven by at-risk groups inevitably impact on the wider population and, subsequently, how they relate to their local area. In identifying, understanding and explicitly engaging with the plurality of meanings that a river and riverside holds for local populations, authorities can improve risk communication and ensure that any flood risk management infrastructure development reflect the desires of whole communities.

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