

# Assessing human perceptions towards large wood in river ecosystems following flooding experiences

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## Abstract

Large wood deposited in rivers provides ecological benefits for multiple trophic groups, but public perceptions of these deposits can be varied. In particular, flooding experiences linked to large wood debris could influence how the public and stakeholders view large wood deposited into the river ecosystem. Here, we assessed the perceptions towards large wood using groups of undergraduates, postgraduates and staff from a local university in Limpopo Province of South Africa. A survey was conducted using questionnaires, which were distributed online to a sample of 104 participants across these groups, using both visual (i.e. paired photographs of different river scenarios) and categorical questions. Large shares of respondents regularly used river systems recreationally (62.9%), with woodless systems perceived as being significantly more aesthetic, less dangerous and least in need of improvement. These perceptions, however, differed among university groups, with staff having stronger perceptions of aesthetics (median = 5.5, mean  $5.4 \pm 2.8$ ), less dangerousness (median = 3.0, mean  $4.2 \pm 3.0$ ) and naturalness (median = 6.0, mean  $5.8 \pm 2.6$ ) towards systems with large wood. Correlation analyses indicated significant interrelatedness among perceptions of aesthetics, naturalness, danger and improvement needs. However, negative perceptions towards large wood in the river were generally not determined by any recent experience of flooding in the area, with large wood-related dangers rather associated with leisure activities in rivers by students. These results highlight a need for passing on the knowledge of natural river systems with wood to people in Vhembe Biosphere Reserve and communities' scientists and assessing wider perceptions outside of the university context.

## KEYWORDS

ecosystem services, flooding, large wood, public perceptions, river ecosystems

## 1 | INTRODUCTION

Large wood comprises logs, sticks, branches or other dead wooden material that falls into rivers and streams, with a diameter > 0.1 m and a length > 1 m (Wohl et al., 2010). Wood in river ecosystems has attracted interest for years due to the value it has in biological and geomorphological processes (Chin et al., 2008; de Brouwer,

Verdonschot, Eekhout, & Verdonschot, 2020; Mazzorana et al., 2018). Wood plays an important role and is increasingly being recognized as beneficial to aquatic biodiversity and ecosystem function by providing habitats for invertebrate and vertebrate organisms, promoting mechanisms for energy dissipation, strengthening riverbanks by preventing soil erosion (i.e. channel stability) and bolstering habitat complexity (Bisson, 2003; Chin et al., 2008; Magliozzi, Usseglio-Polatera, Meyer,

& Grabowski, 2019; Osei, Gurnell, & Harvey, 2015; Ruiz-Villanueva, Badoux, et al., 2018; Ruiz-Villanueva, Díez-Herrero, et al., 2018). Large wood can also decrease water temperature through the creation of cooler water pockets and trap organic matter that provides food for invertebrates, vertebrates and fungi (Kruys & Jonsson, 1999; Osei et al., 2015; Yee, Yuan, & Mohammed, 2001), which in turn decompose large wood, contributing to wider river nutrient cycling.

However, large wood in river systems can increase flooding by hindering the flow of water, leading to the accumulation of sediments (Chin et al., 2014; Collins, Montgomery, Fetherston, & Abbe, 2012; Gurnell, Piégay, Swanson, & Gregory, 2002). Floods are a natural hazard, although anthropogenic activities, heavy rainfall, topography, vegetation cover and soil type can alter their magnitude and frequency (Musyoki, Thifhulufhelwi, & Murungweni, 2016). While floods can bring benefits, their potential to cause damage to infrastructure or loss of livelihoods (Wohl, 2017), wood additionally poses a danger to water sport activities and impedes transportation. In terms of benefits, floodwaters carry soil that is fertile and rich in nutrients, which sustains aquatic vegetation that is, macrophytes and phytoplankton (Dube, Mtapuri, & Matunhu, 2018). Thus, the presence of large wood might cause a reduction in downstream discharge and increases water retention upstream if it completely or partially blocks the channel, contributing to the biological and structural quality of streams. These positive and negative effects warrant quantification of perceptions and assessment of whether large wood in river systems is acceptable to different communities and stakeholders (Mutz et al., 2006).

The reappearance of large wood debris in heavily modified rivers has been seen as a river restoration indicator (Gurnell et al., 1995; Gurnell, 2012; MacVicar et al., 2009). Accordingly, river managers may have different perceptions of large wood in comparison to those of the general public. River managers view rivers with large wood as significantly more aesthetic, natural and require less improvement than those without wood (Chin et al., 2014; Mutz et al., 2006). Contrastingly, the public, due to lack of knowledge, tends to hold negative perceptions towards large wood in river systems (Chin et al., 2008, 2014). Gender, education level, income and duration of stay in the community have been identified as variables that influence how people perceive large wood in river ecosystems (Gapinski, Hermes, & von Haaren, 2021; Ruiz-Villanueva, Díez-Herrero, et al., 2018; Wyzga, Zawiejska, & Le Lay, 2009). Thus, different people within a community can hold conflicting perceptions towards large wood in rivers; but strong positive perspectives can also resonate (Addo & Danso, 2017). Negative public perceptions have prompted the removal of wood, due to perceived flooding risk, bank erosion and damaging of infrastructure (Chin et al., 2014; Ruiz-Villanueva, Badoux, et al., 2018; Ruiz-Villanueva, Díez-Herrero, et al., 2018). In particular, large wood brought in by floods can also affect the lives of people living in the surrounding river areas, and possibly lead to the negative perceptions they may have regarding large wood in rivers. For others, the positive role of wood in rivers has promoted the reintroduction of wood debris for the benefits it brings to aquatic organisms (Chin et al., 2008; Gregory, Meleason, & Sobota, 2003). In turn, divergent public perceptions tend to influence the land managers' decision making (Chin et al., 2008, 2014).

There is accordingly a need to convey the importance of large wood in rivers to the general public and policymakers, as variations in perceptions need to be addressed in developing national strategies for education and river management. Thus, river managers believe that the issue of wood in rivers should be taught in schools so that students can have positive perceptions towards large wood given their ecological benefits (Chin et al., 2008). This study investigated general perceptions of university member groups (i.e. staff, postgraduate and undergraduate students) concerning large wood in the river ecosystem following recent flooding experiences. We aimed to identify the views of university member groups with regards to large wood in rivers following flooding events and to assess how the opinions of the university member groups differ.

## 2 | MATERIALS AND METHODS

### 2.1 | Study area

This study focused on a local university located within the Vhembe District, Limpopo Province of South Africa. The population demographics of the district are highlighted in Table 1. The district is approximately 25,597 km<sup>2</sup> in size and is considered a humid and semi-arid zone. Some parts of the Vhembe District have experienced floods in recent years and flooding has been increasing since 2002, with the last flooding occurring in February 2019 in villages such as Mangaya, Tshanzhe and Maheni.

### 2.2 | Data collection

Perception of wood in river systems was assessed using online questionnaires to local rural university community representatives based on Piégay et al. (2005) and Ruiz-Villanueva, Díez-Herrero, et al. (2018), employing a combination of visual perception of 20 colour photographs of riverscapes (i.e. 10 scenes with and 10 without wood). Respondents were also asked background information regarding their gender, age, education status, personal residence (in rural or urban areas, watercourse proximity), frequency and reason of watercourse visits. Similar to Ruiz-Villanueva, Díez-Herrero, et al. (2018), we used the same scenes and questions, and added river management questions at the end of the survey focusing on (i) interventions to reduce flood risk, (ii) streambed clearance and bank stabilization, (iii) landscape and ecosystem enhancement and (iv) the absence of river interventions. The questionnaire was distributed either online or in person. The participants were not informed that the survey focused on wood perception but instead thought that it was to evaluate riverscapes. Each respondent was asked to rank each riverscape scene from 0 (low) to 10 (high), based on a scalar grading according to aesthetics, naturalness, danger and any possible need for improvement (Ruiz-Villanueva, Díez-Herrero, et al., 2018). The need for improvement and danger were further analysed by the respondents for the type of improvement and perceived danger. Respondents could select the type of improvements, ranging from no improvement, scenic beauty,

**TABLE 1** Population demographics of Vhembe District for the year 2016. Source: [www.municipalities.co.za](http://www.municipalities.co.za)

Population	1,393,949				
Age structure	Population (<15)	Population (15–64)	Population (>65)		
	34.20%	61.00%	4.70%		
Sex ratio: Males per 100 females	85.80%				
Population growth: Per annum	1.68%				
Labour market	Unemployment rate (official)	Youth unemployment rate (official) 15–34			
	N/A but was 38.7% in 2011	N/A but was 50.6% in 2011			
Education (aged 20+)	No schooling	Matric	Higher education		
	14.40%	25.00%	9.60%		
Household dynamics	Households	Average household size	Female-headed households	Formal dwellings	Housing owned
	382,357	3.60%	51.00%	86.30%	76.90%
Household services	Flush toilet connected to sewerage	Weekly refuse removal	Piped water inside the dwelling	Electricity for lighting	
	16.00%	16.50%	7.40%	94.60%	
Dependency ratio: Per 100 (15–64)	63.80%				

habitats for fauna, channel cleaning, bank stabilization, flooding risk mitigation engineering measures and other improvements, whereas, the danger type perceived was based on different modalities, such as no danger, flooding or inundation, bank erosion, practising of leisure activities and degraded water quality and/or other danger.

The online survey was uploaded and distributed using a link on Google forms (<https://docs.google.com/forms/d/1G6Ontp3MSFPtlixSUGas3Eb0VAdR7se1RSBeOk0gkQ/edit#responses>) to different people within the university, comprising of staff (i.e. lecturers, researchers, managers), postgraduate and undergraduate students, because we believed that an educated opinion is valued yet there are still negative sentiments as it affects our daily lives. The online survey was available between June 2019 and July 2019, and the questionnaire was anonymous. The survey initially involved 380 respondents from the Faculty of Sciences, University of Venda, but was only completed by 104 staff ( $n = 16$ ), postgraduate ( $n = 29$ ) and undergraduate students ( $n = 59$ ), leaving 276 incomplete responses. The different groups (i.e. staff, post- and undergraduate) were selected due to their different education levels and assumed prior knowledge on aquatic ecosystems.

## 2.3 | Data analysis

All results from the questionnaires were exported from Microsoft Excel and analysed statistically using SPSS version 16 (SPSS Inc., 2007). The respondents' scores for each feature were evaluated and the data were used to compare differences between systems with or without wood using Mann–Whitney tests for each individual group (i.e. staff, postgraduate, undergraduate), whereas comparisons among respondent groups were computed using Kruskal–Wallis tests.

Furthermore, Spearman correlations were used to test for relationships among the scores for naturalness, aesthetics, improvement and danger.

## 3 | RESULTS

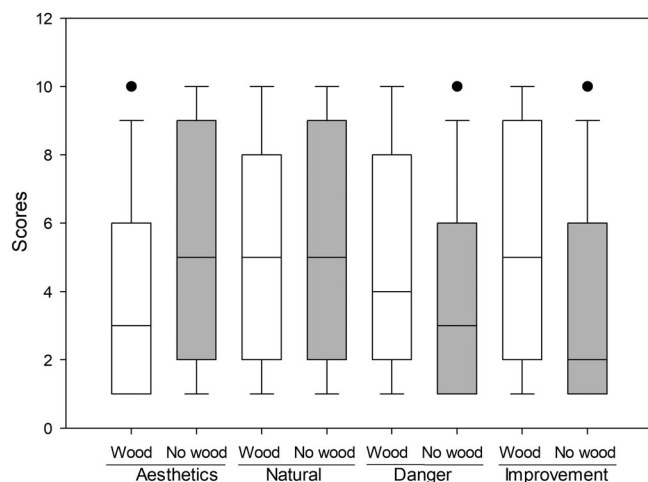
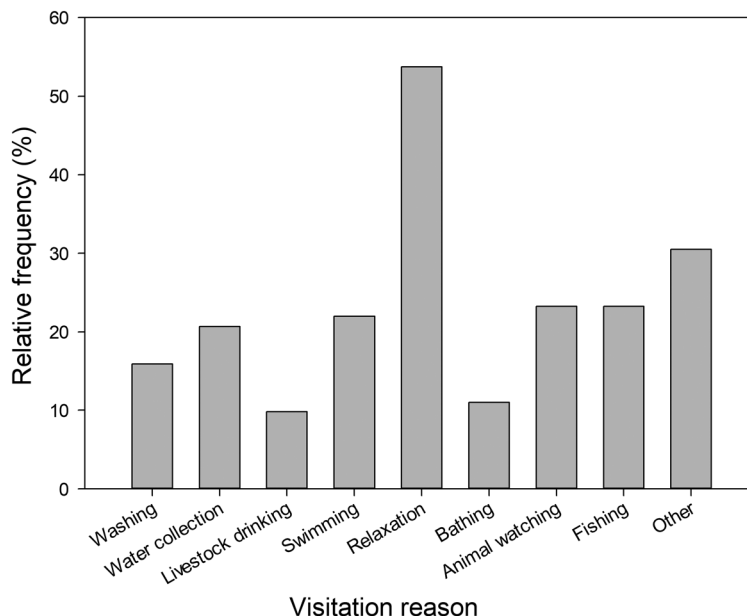
### 3.1 | Background information

Females and males were 51.1% and 47.8%, respectively, with 1.1% being non-binary. The 20–29 year age group was the most dominant (63.7%), followed by 18–20 and 30–39 year-olds at 26.4% and 7.7% respectively. Undergraduates, postgraduates and staff were 57.0%, 27.5% and 15.5% respectively. The majority of the respondents resided in rural areas (92.5%), and 7.5% lived in urban areas. Approximately 68.8% live close to river systems, with the majority of respondents visiting the river at least one to five times a year (55.1%), less than once a year (22.5%), 6 to 20 times a year (10.1%) and > 20 times a year (12.4%). Only 22.8% of all respondents have experienced flooding events during the past 10 years.

### 3.2 | Perceptions of large wood in river ecosystems

Most respondents visited the river for leisure activities (62.9%), while 19.1% and 32.6% of the respondents visited the riverscapes for professional/training and domestic activities respectively. The respondents who answered 'yes' to leisure and domestic activities were further interrogated on why exactly they visited the systems, and

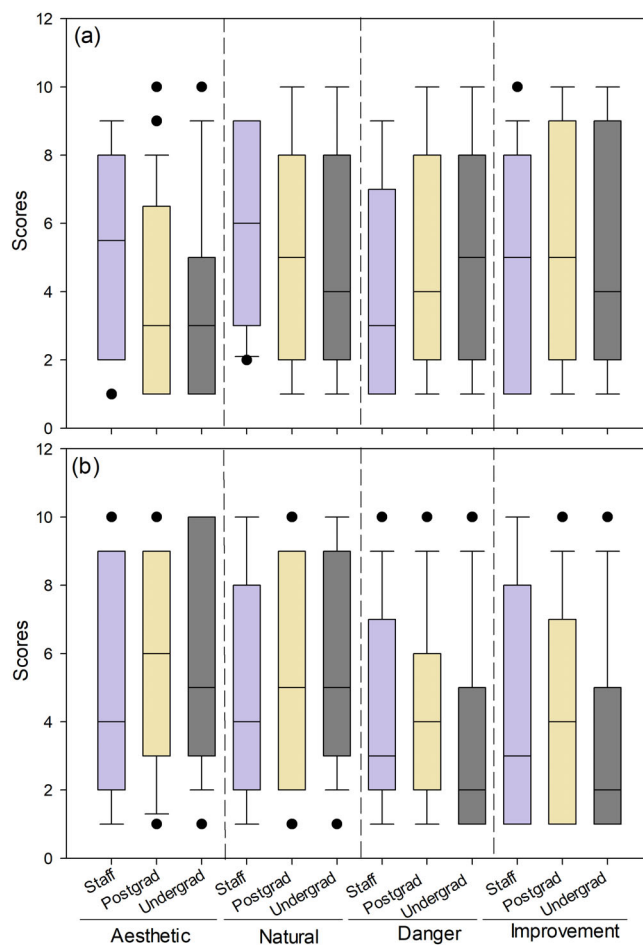
**FIGURE 1** Frequency of reasons why respondents visited a river, for those that engaged in leisure and/or domestic activities there



**FIGURE 2** Box and whisker plots of all responses to river scenes with and without wood regarding aesthetics, naturalness, degree of danger and need for improvements. The whiskers of the box indicate the minimum (0th quartile; the lowest data point excluding any outliers) and maximum (100th quartile; the highest data point excluding any outliers). The first (bottom of box) and third (top of box) quartiles are the 25% and 75% zones, respectively, of the data, whereas the middle (second quartile) box line is the median, and black circles are outliers. Choices were between 0 (minimum, lowest or negative value) to 10 (maximum or highest value)

their responses are presented in Figure 1. Relaxation/rest (53.7%), other activities (30.5%), animal watching (23.2%), fishing (23.2%) and swimming (22.0%) had high relative frequencies (note that the options are not mutually exclusive).

The respondents' perceptions, based on whether a photo looked aesthetically pleasing, natural, dangerous and if there was any need for improvement, are presented in Figures 2 and 3. Generally, rivers with large wood were more negatively perceived than those without



**FIGURE 3** Box and whisker plots of scores given by staff, postgraduate and undergraduate students to all riverscapes (a) with and (b) without wood regarding aesthetics, naturalness, degree of danger and needs for improvement. The description of the box and whisker plot and choices are provided in Figure 2 [Color figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]

Categories	Staff		Postgraduate		Undergraduate	
	Z	p	Z	p	Z	p
Aesthetics	-0.253	0.801	<b>-3.228</b>	<b>0.001</b>	<b>-7.823</b>	<b>&lt;0.001</b>
Natural	-0.986	0.324	-0.267	0.789	-2.727	0.006
Danger	-0.371	0.710	-2.002	0.045	<b>-5.118</b>	<b>&lt;0.001</b>
Improvement	-0.283	0.777	<b>-3.186</b>	<b>0.001</b>	<b>-6.341</b>	<b>&lt;0.001</b>

Note: Bold values indicate significance at  $p < 0.05$ .

**TABLE 2** Mann–Whitney test results indicating level of significance differences among university groups (i.e. staff, postgraduate, undergraduate) among the assessed categories

**TABLE 3** Spearman correlation matrices highlighting the  $r$  (white shade) and  $p$  (grey shade) values for aesthetics, naturalness, danger and need for improvement among the different study groups (i.e. staff, postgraduate, undergraduate)

Wood	Wood				No wood			
	Aesthetics	Natural	Danger	Improvement	Aesthetics	Natural	Danger	Improvement
Staff								
Aesthetics	1	<b>0.86</b>	-0.78	-0.74	1	<b>0.94</b>	-0.53	-0.76
Natural	<b>&lt;0.001</b>	1	-0.87	-0.80	<b>&lt;0.001</b>	1	-0.46	-0.75
Danger	<b>&lt;0.001</b>	<b>&lt;0.001</b>	1	<b>0.93</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	1	<b>0.75</b>
Improvement	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	1	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	1
Postgraduate								
Aesthetics	1	<b>0.69</b>	<b>0.36</b>	<b>0.29</b>	1	<b>0.73</b>	<b>0.23</b>	<b>0.23</b>
Natural	<b>&lt;0.001</b>	1	<b>0.52</b>	<b>0.53</b>	<b>&lt;0.001</b>	1	<b>0.41</b>	<b>0.35</b>
Danger	<b>&lt;0.001</b>	<b>&lt;0.001</b>	1	<b>0.82</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	1	<b>0.76</b>
Improvement	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	1	<b>&lt;0.001</b>	<b>&lt;0.001</b>	<b>&lt;0.001</b>	1
Undergraduate								
Aesthetics	1	<b>0.64</b>	-0.02	-0.16	1	<b>0.75</b>	-0.02	-0.07
Natural	<b>&lt;0.001</b>	1	<b>0.36</b>	0.16	<b>&lt;0.001</b>	1	-0.01	0.04
Danger	0.972	<b>&lt;0.001</b>	1	<b>0.71</b>	0.794	0.825	1	<b>0.68</b>
Improvement	0.008	0.008	<b>&lt;0.001</b>	1	0.263	0.469	<b>&lt;0.001</b>	1

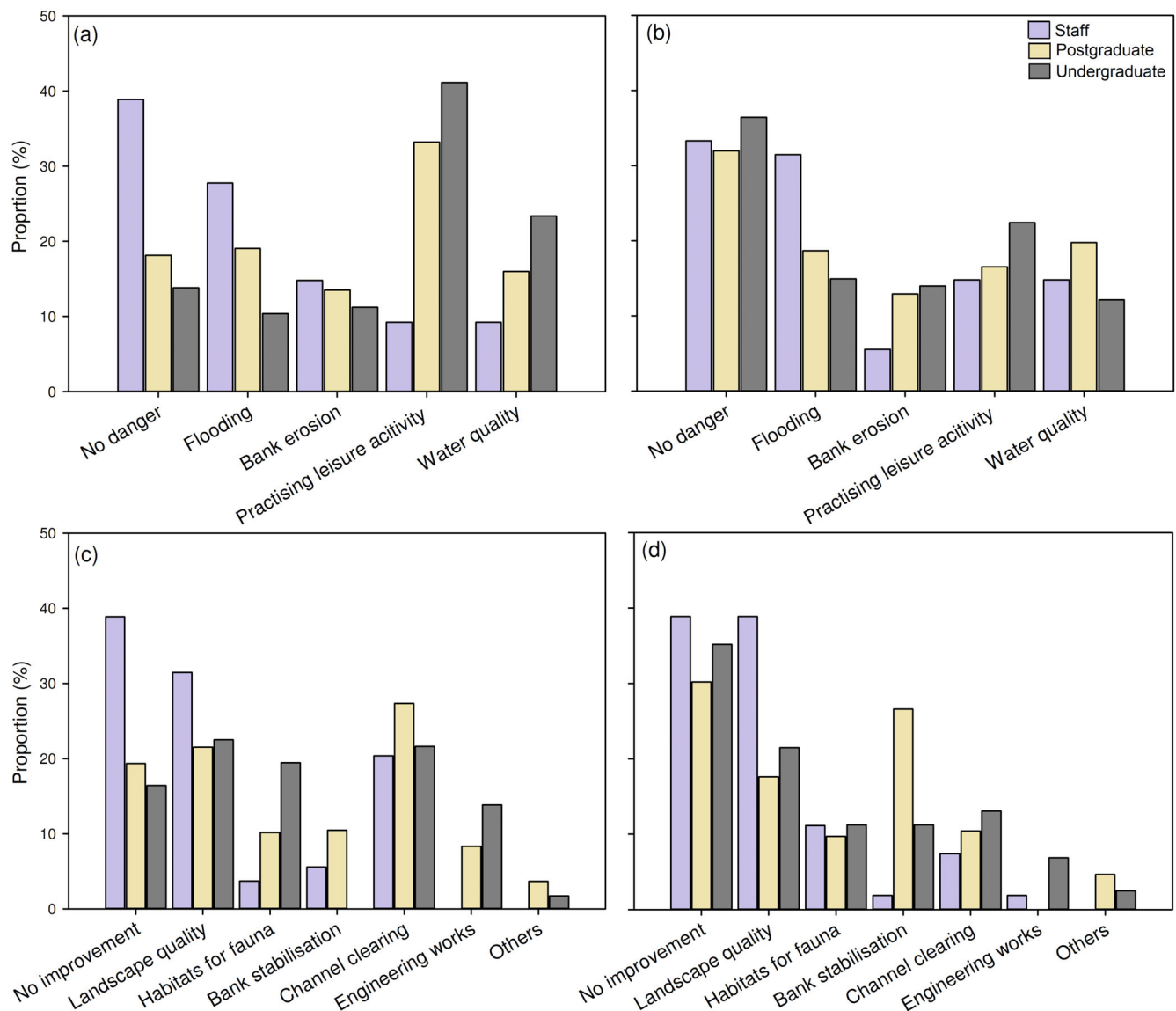
Note: Bold values indicate significance at  $p < 0.05$  for  $r$  and  $p$ -values.

wood when all respondents were combined (Figure 2). For example, respondents perceived rivers without wood to be aesthetically pleasing (median 5.0, mean  $5.3 \pm 3.3$  [SD]), less dangerous (median 3.0, mean  $4.0 \pm 3.0$ ) and required less improvements (median 2.0, mean  $3.9 \pm 3.2$ ) compared those with wood (aesthetics – median 3.0, mean  $4.0 \pm 3.0$ ; dangerous – median 4.0, mean  $4.9 \pm 3.3$ ; need for improvement – median 5.0, mean  $5.2 \pm 3.5$ ) (Figure 2). In terms of naturalness, rivers with wood (median 5.0, mean  $5.1 \pm 3.1$ ) and no wood (median 5.0, mean  $5.3 \pm 3.3$ ) received similar ratings (Figure 2).

When comparisons were made among staff, postgraduate and undergraduate students regarding danger perceptions in rivers with wood, staff respondents highlighted that these river systems were aesthetical pleasing (median = 5.5, mean  $5.4 \pm 2.8$ ) and natural (median = 6.0, mean  $5.8 \pm 2.6$ ), with postgraduate and undergraduate students having the lowest median of 3.0 (mean  $3.6 \pm 2.9$ ) and 3.0 (mean  $3.9 \pm 2.9$ ), respectively (Figure 3a) for aesthetics. Furthermore, staff respondents found rivers with wood to be less dangerous (median = 3.0, mean  $4.2 \pm 3.0$ ). Postgraduate and undergraduate students found rivers with wood to be in need of improvements (median = 5.0, mean  $5.3 \pm 3.4$ ) and dangerous (median = 5.0, mean

$5.0 \pm 3.2$ ) respectively (Figure 3a). Similarly, both student groups found that river systems without wood were more aesthetically pleasing, with staff scoring lowest (median 4.0, mean  $4.8 \pm 3.2$ ) (Figure 3b). Interestingly, most postgraduate students (perception median 5.0, mean  $5.1 \pm 3.2$ ) and staff (perception median 6.0, mean  $5.8 \pm 3.2$ ) perceived rivers with wood to be natural, with undergraduates perceiving rivers without wood to be natural (perception median 5.0, mean  $5.6 \pm 3.3$ ) (Figure 3). Using Mann–Whitney tests, no significant differences ( $p > 0.05$ ) were observed for many of the assessment categories, with significant differences ( $p < 0.05$ ) being observed for aesthetics and need for improvement in postgraduate students, and aesthetics, danger and need for improvement in undergraduate students (Table 2).

Responses by staff and postgraduate students showed significant correlations for aesthetics, naturalness, danger and need for improvement among rivers with and without wood (Table 3). However, staff tended to exhibit negative correlations and postgraduates positive correlations. For undergraduates, most of the values were found to be non-significant ( $p > 0.05$ ). However, strong positive, significant correlations were observed for naturalness versus aesthetics ( $r = 0.64$ ,  $p < 0.001$ ), naturalness versus danger ( $r = 0.36$ ,  $p < 0.001$ ) and danger



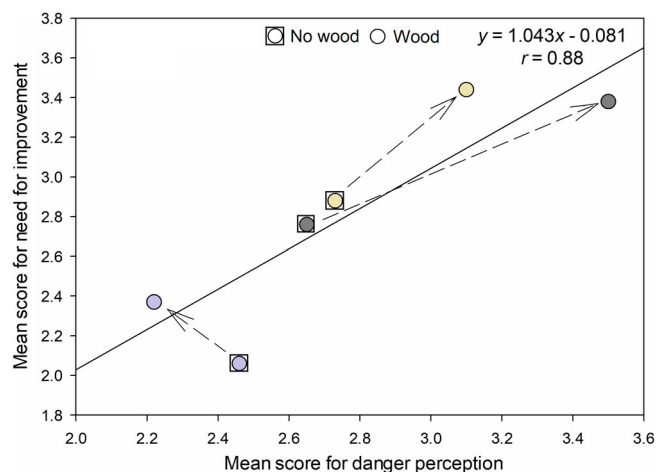
**FIGURE 4** Frequency distribution of (a, b) perceived danger types and (c, d) improvement areas needed for all questionnaire pictures with (a, c) and without (b, d) wood for university staff, postgraduate and undergraduate students [Color figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1002/rm.4009)]

versus improvement ( $r = 0.71$ ,  $p < 0.001$ ) in rivers with wood, whereas, positive and significant relationships were observed for naturalness versus aesthetics ( $r = 0.75$ ,  $p < 0.001$ ) and danger versus improvement ( $r = 0.68$ ,  $p < 0.001$ ) (Table 3).

Most of the respondents agreed that river management interventions should (i) reduce flood risk in the surrounding areas (agreed – 92.3%; disagreed – 7.7%), (ii) be focused on streambed clearance and bank stabilization (agreed – 80.0%; disagreed – 20.0%) and (iii) be focussed on landscape and ecosystem enhancement (agreed – 88.6%; disagreed – 11.4%), while 69.7% of the respondents suggested that we should leave nature to function without river interventions. The perceived danger and areas requiring improvements based on responses are presented in Figure 4. Significant differences ( $H = 35.742$ ,  $p < 0.001$ ) were observed in systems with or without wood among the different respondents. In river systems with wood,

staff respondents (38.9%) highlighted that most rivers posed no danger whereas in rivers without wood respondents from student groups indicated that they posed no danger. In rivers with wood, danger when practising leisure activities such as swimming, hiking and boating was considered to be high among the postgraduate (33.2%) and undergraduate (41.1%) students (Figure 4a). Significant differences were observed in danger among postgraduate ( $Z = 2.978$ ,  $p = 0.003$ ) and undergraduate ( $Z = 6.549$ ,  $p < 0.001$ ) students in systems with and without wood, whereas no significant differences ( $Z = 0.765$ ,  $p = 0.445$ ) were observed by staff respondents.

Significant differences ( $H = 36.018$ ,  $p < 0.001$ ) were observed among respondents with regards to areas that required improvements in rivers with or without wood. Similarly, the largest share of staff respondents highlighted that rivers with and without wood needed no improvements and also needed landscape quality improvement



**FIGURE 5** Regression analysis of the relationship between mean scores for the perception of danger and the need for improvement attributed to river scenes with wood and without wood for university community groups. Dashed lines indicate change paths in the danger and need for improvement appraisal. Colours: purple – staff, orange – postgraduate and grey – undergraduate [Color figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com)]

(Figure 4c). Furthermore, large shares of postgraduate student respondents highlighted that rivers with wood required flood risk management by channel clearing (27.4%) and without wood required bank stabilization by engineering works (26.6%) (Figure 4c,d). Rivers with or without wood were perceived to require different improvements according to postgraduate ( $Z = 4.273$ ,  $p < 0.001$ ) and undergraduate ( $Z = 4.310$ ,  $p < 0.001$ ) students, whereas staff members considered them to be similar ( $Z = 0.614$ ,  $p = 0.539$ ).

A strong relationship ( $r = 0.88$ ) of the group mean scores for perceived danger and need for improvement was recognized for riverscapes in relation to how each group perceived changes in rivers with wood to those without wood (Figure 5). The postgraduate and undergraduate students highlighted rivers with wood were in need of improvements and also dangerous, whereas staff indicated rivers with wood needed slight improvements, but were not dangerous, with a slight reduction in the scale of the change.

## 4 | DISCUSSION

The perception of wood in riverscapes has been shown to differ among regions due to variation in socio-cultural and economic backgrounds, largely paralleling perceived wood dangers and/or benefits within riverscapes. This study found that the general perceptions of university member groups (i.e. staff, postgraduate and undergraduate students) concerning large wood in the river ecosystem following recent flooding experiences differed significantly, with university staff respondents having a more positive perception to the presence of wood than postgraduate and undergraduate students, who perceived rivers with woods more negatively. This difference in wood presence perception within river systems suggests that the well-educated staff

respondents have better knowledge regarding environmental importance, benefits and functions resulting from the occurrence of wood in river systems, which allow them to overcome negative perceptions typical of postgraduate and undergraduate student respondents (see also Wyzga et al., 2009). In support of the current study findings, Chin et al. (2014) highlighted that environmental and conservation managers perceived rivers with wood to be more aesthetically pleasing, less dangerous and needing less improvements. Similarly, Piégay et al. (2005) and Chin et al. (2008) highlighted that student perceived the presence of wood in rivers more negatively as unaesthetic, dangerous and needing improvements, whereas, Wyzga et al. (2009) indicated that negative perception of rivers with wood can be significantly modified over the course of academic education which was also observed within the current study.

Thompson and Barton (1994) indicated that human perceptions to the environment may reflect two general attitudes, being either ecocentric (focused on the environment or preserving all organisms in nature) or anthropocentric (humans have greater intrinsic value than other species, that is, the environment is valued on the basis of benefits provided). Therefore, the current study highlighted staff to potentially have a more ecocentric attitude, with a more anthropocentric attitude possible among student members that could have led to the varied evaluation of wood-containing river systems. However, given that attitudes can be mediated by experience and knowledge, it is similarly plausible that students equally have ecocentric views that are dampened in this context by a poorer understanding of stream science. Thus, river systems with wood were similarly negatively perceived by both student groups (Figure 3). These results might have been attributed to the dangers or past experiences of students in their home villages where wood is negatively perceived. For example, postgraduate and undergraduate students considered rivers with wood to be dangerous for practising leisure activities but not related to flooding, however, staff respondents exhibited the opposite. Thus, both students considered flood impacts to be less dangerous than leisure activities; however, staff respondents appeared to understand the potential impacts or dangers of flooding, due to the presence of wood through creation of dams that might cause greater flooding risks. These differences in perception have been further highlighted by Ruiz-Villanueva, Díez-Herrero, et al. (2018) in Spain, where experts had a better understanding large wood importance. Therefore, there is a need to impart the importance of large wood in river systems via knowledge transfer activities, training and education to bridge this gap. Since most of the respondents who participated in this study will continue with their education, ending in professional careers, it is anticipated that this is expected to change their perceptions of wood presence in river systems as they gain more knowledge on the importance, functions and aesthetics of large wood in aquatic ecosystems. Similarly, Mutz et al. (2006) highlighted that perception of students towards wood tend to change from negative to positive during their educational progression. However, given that respondents here were all from a natural sciences background in the university context, any negative perceptions of large wood in these groups were likely conservative compared to other areas of study, employment or wider community groups.

The outcomes of this study indicate that different university groups, particularly the students, tend to perceive rivers with wood to be less aesthetically pleasing, with the exception of staff members. Many respondents reside closer to river systems, such that they consider the presence of wood to alter the aesthetics, which could be the reason why they think rivers with wood look less pleasing and aesthetic. The aesthetics river scores were generally high in river systems without wood than in those with wood, similar to Scheaffer et al. (2012) and Ruiz-Villanueva, Díez-Herrero, et al. (2018). Large wood debris in heavily modified rivers in Europe has been additionally seen as an indicator of river restoration (Gurnell et al., 1995; Gurnell, 2012), and sometimes plays a role of restoring the life of rare species after flooding events (Gurnell et al., 2002; Nagayama, Kawaguchi, Nakano, & Nakamura, 2008). Some of the respondents were unfamiliar to wood in river systems regardless of living near these systems, and this suggests little knowledge on the usefulness and functionality of large wood in rivers. Therefore, people need to be educated about the importance and ecological values of wood in river systems, which may at some point help change their perceptions towards its presence in these systems (Chin et al., 2008, 2014).

## 5 | CONCLUSIONS

It is important to highlight that the loss of large wood in river systems has been shown to alter river form and processes, contributing to increased bank erosion, sediment fluxes and loss of river bed morphology heterogeneity (Wohl et al., 2016). Postgraduate and undergraduate students gave more negative responses or perceptions towards the presence of large wood in river ecosystems as they found them to be less aesthetically pleasing and dangerous. Thus, the negative perception of large wood in river systems may cause socially appreciated wood removal actions (Ruiz-Villanueva, Díez-Herrero, et al., 2018). In cases where people consider large wood as aesthetically pleasing and not dangerous, these perceptions could have important consequences for the implementation of river management and restoration measures.

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### AUTHORS' CONTRIBUTIONS

MTBD and TD were involved in conceptualization, methodology, data curation, formal analysis, supervision and writing—original draft, review and editing; RNC, AWG and FD were involved in visualization,

methodology and writing—original draft, review and editing; PR was involved in investigation, formal analysis, data curation and writing—original draft, review and editing.

### CONFLICT OF INTERESTS

All authors declare no conflict or financial interests exist for the manuscript.

### ETHICS APPROVAL

The University of Venda Research Ethics Committee provided clearance for the research under ethics number SES/18/ERM/20/0312.

### CONSENT FOR PUBLICATION

Not applicable, all data were collected by the authors.

### DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author, [TD], upon reasonable request.

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