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Taxonomic structure and spatial distribution of aquatic invertebrates from temporary wetlands after a severe drought event in southern Brazil

Estrutura taxonômica e distribuição espacial de invertebrados aquáticos de zonas úmidas temporárias após evento de seca severa no sul do Brasil

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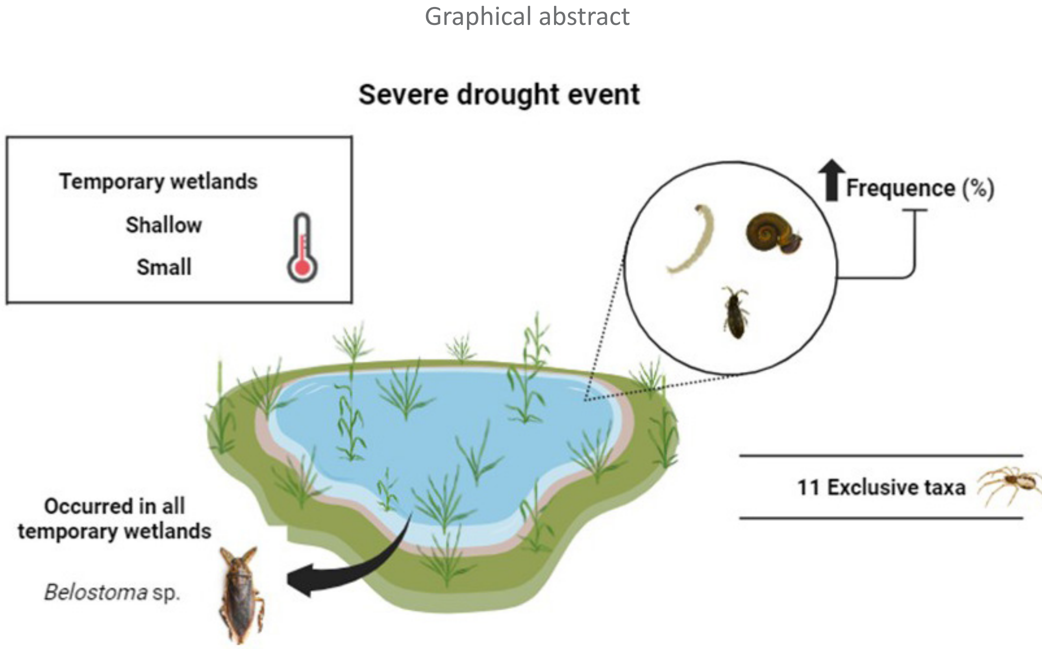
Abstract: Aim: The aim of this study was to evaluate the composition and spatial distribution of aquatic invertebrates in temporary wetlands following a severe drought event in southern Brazil. **Methods:** Aquatic invertebrates and limnological variables were collected from 14 temporary wetlands located on the campus of the Federal University of Rio Grande, Rio Grande do Sul State, Brazil, after a severe drought period in the summer de 2024. **Results:** The temporary wetlands were characterized by small size (70.8 – 336.0 m^2), shallow depth (9.0 – 36.0 cm), and water temperature between 20.5 and 29.4 ºC. A total of 3230 invertebrates were identified, encompassing 55 different taxa. The most frequent groups were Diptera (761 individuals), Collembola (526 individuals), and Gastropoda (498 individuals). Additionally, 11 unique taxa were found in temporary wetlands analyzed, with the majority belonging to Arachnida. Based on taxa abundance, two main clusters were observed, the first being composed of temporary wetlands (TW) from 1 to 9, and the second cluster with areas 10 to 14. **Conclusions:** Climate change projections suggest a rising frequency and potential for severe drought events. Temporary wetlands, which harbor significant diversity of aquatic invertebrates, are particularly vulnerable due to their characteristics and dependence on hydroperiods. Severe drought events may impact species composition and distribution, highlighting the need for monitoring and protection of these habitats.

Keywords: temporary ponds; invertebrate fauna; aquatic biodiversity; climate changes.

Graphical abstract



Resumo: Objetivo: O objetivo deste estudo foi de avaliar a composição e distribuição espacial de invertebrados aquáticos em zonas úmidas temporárias após um evento de seca severa no sul do Brasil. **Métodos:** Invertebrados e variáveis limnológicas foram coletados em 14 zonas úmidas temporárias distribuídas no Campus da Universidade Federal do Rio Grande, Rio Grande do Sul, Brasil, durante um período de seca severa no verão de 2024. **Resultados:** As zonas úmidas temporárias eram pequenas (70,8 – 336,0 m^2), rasas (9,0 – 36,0 cm) e temperatura da água entre 20,5 e 29,4 ºC. Foram contabilizados ao total 3230 invertebrados, distribuídos em 55 táxons. Diptera (761 indivíduos), Collembola (526 indivíduos) e Gastropoda (498 indivíduos) foram os grupos mais frequentes. Além disso, 11 táxons únicos foram encontrados em áreas úmidas temporárias analisadas, com a maioria pertencente a Arachnida. Com base na abundância de táxons, foram observados dois agrupamentos principais, sendo o primeiro composto por áreas úmidas temporárias (TW) de 1 a 9, e o segundo agrupamento com áreas de 10 a 14. **Conclusões:** Projeções de mudanças climáticas indicam um aumento na frequência e na potencialidade de eventos de seca severa. As zonas úmidas temporárias abrigam importante diversidade de invertebrados aquáticos e estes são vulneráveis devido as suas características e relação com os hidroperíodos. Não encontramos registros de monitoramento dessas zonas úmidas. Eventos severos de seca poderão afetar a composição e distribuição de espécies, sendo necessário o monitoramento e proteção desses habitats.

Palavras-chave: poças temporárias; fauna de invertebrados; biodiversidade aquática; mudanças climáticas.

1. Introduction

Water bodies that experience variable dry periods, usually characterized by their shallow depth, small size, and varied landscape configurations, are defined as temporary wetlands (Williams, 1996; Calhoun et al., 2017). These environments are considered biodiversity hotspots (Parra et al., 2021), significantly contributing to the increase of biodiversity due to their ephemeral and semi-permanent characteristics in terrestrial areas (Boix et al., 2020). They harbor distinct taxonomic compositions compared to permanent wetlands (Zacharias et al., 2007), including specialized, exclusive, or endemic species (Bozelli et al., 2018), and provide foraging and resting areas for species that migrate to other environments (Calhoun et al., 2017).

Among the various organisms in temporary wetlands, aquatic invertebrates are one of the most important groups (Wissinger, 1999). They are numerically dominant compared to other animal groups (Mlambo et al., 2011). Invertebrates act as a link between different trophic levels (Stenert & Maltchik, 2007; Poi et al., 2021) through food webs (Albertoni & Palma-Silva, 2010), breaking down and consuming organic matter (Richardson, 2020), contributing to nutrient cycling (Ramírez & Gutiérrez-Fonseca, 2014), and serving as environmental indicators (Conceição et al., 2020; Santana et al., 2021).

With the accelerated advance of climate change, the effects on the global climate can already be observed. Severe events such as heat waves, high levels of precipitation, droughts and cyclones are increasingly frequent (IPCC, 2023). Among the wetlands, temporary areas are the ones that suffer the most from the effects of climate change, which can lead to a reduction in the areas covered or even cause their disappearance due to their small size (Bozelli et al., 2018). Consequently, these aspects influence the structure, distribution and interaction of species (Junk et al., 2013). Despite the recognized importance and vulnerability of invertebrates associated with temporary wetlands, there are few studies to monitor these ecosystems, considering that most studies are focused on permanent wetland fauna and streams (Jourdan et al., 2018; Boggero et al., 2023; Firmino et al., 2023; Necker et al., 2023).

Temperature, rainfall seasonality, and desiccation of temporary wetlands are important factors in determining the diversity of invertebrates associated with these ecosystems (Zacharias et al., 2007; Epele et al., 2022). This makes temporary wetlands an unpredictable and variable habitat for invertebrates (Silver et al., 2012). Thus, species that colonize temporary environments must be adapted to these events (Williams, 2006), or by seeking refuges with water retention (Humphries & Baldwin, 2003) through migration, or survival through mechanisms of resistance (Williams, 1996; Pérez-Bilbão et al., 2015). Although such adaptations do not ensure full protection from these events, the nature of the individual's adaptations and the severity of the drought can influence how affected a group will be (Humphries & Baldwin, 2003).

Thus, taxes adapted to severe conditions can resist such environmental changes. However, effects on species richness can occur at these sites. As found by Epele et al. (2022), in humid areas with low precipitation (dry) and high temperature conditions, richness in the macroinvertebrate assemblage decreases. However, there are still many gaps that permeate the way aquatic invertebrate fauna responds to climate change (Collier et al., 2016), especially in relation to the lack of data on species composition under severe conditions for the comparison between different environmental conditions. In this same context, there is great concern the scientific community regarding the cumulative effects of severe heat events and droughts, which are prolonging the dry periods of temporary wetlands (Maltchik et al., 2024), and consequently, can affect the biodiversity of these environments.

The State of Rio Grande do Sul (RS) has been suffering from extreme weather events of drought (Tonetto et al., 2024) and excessive rainfall (Marengo et al., 2024) in recent years. Among the climatic phenomena, droughts are the most frequent (Teixeira et al., 2013; Tonetto et al., 2024), and the increase in the intensity of these events has been observed (Pelinson & Fan, 2023). Although the northeastern region of Brazil is widely recognized for drought events (Brito et al., 2018; Cunha et al., 2019), these events can occur in regions (Pelinson & Fan, 2023) with different climates, even those predominantly humid (Teixeira et al., 2013) as in the case of RS. Specifically, one of the municipalities in the southern region of the state, Rio Grande, recorded over the historical period of 1913-2016 the occurrence of 219 months of extreme drought events (Silva et al., 2019), in addition to suffering from the effects of the event of the year 2020 (Pelinson & Fan, 2023).

Given that climate change projections indicate a higher frequency and intensity of severe drought events, which can impact the composition and distribution of aquatic invertebrate species, and considering the scarcity of information, for temporary wetland environments, the following question arises: What is the composition of aquatic invertebrates after a period of severe drought in different temporary wetlands? Thus, the objective of this study was to evaluate the composition and spatial distribution of aquatic invertebrates in temporary wetlands following a severe drought event in southern Brazil.

2. Material and Methods

2.1. Study area

Fourteen temporary wetlands (Figure 1) were sampled within the Carreiros Campus (32°04'09.2" S 52°10'11.1" W) of Universidade Federal do Rio Grande, Rio Grande – RS, Brazil. The sampling was conducted in March 2024, a period characterized as summer in the region. The municipality is located in the southern portion of the coastal plain of the state of Rio Grande do Sul. The plain is characterized by the interaction between terrestrial and aquatic

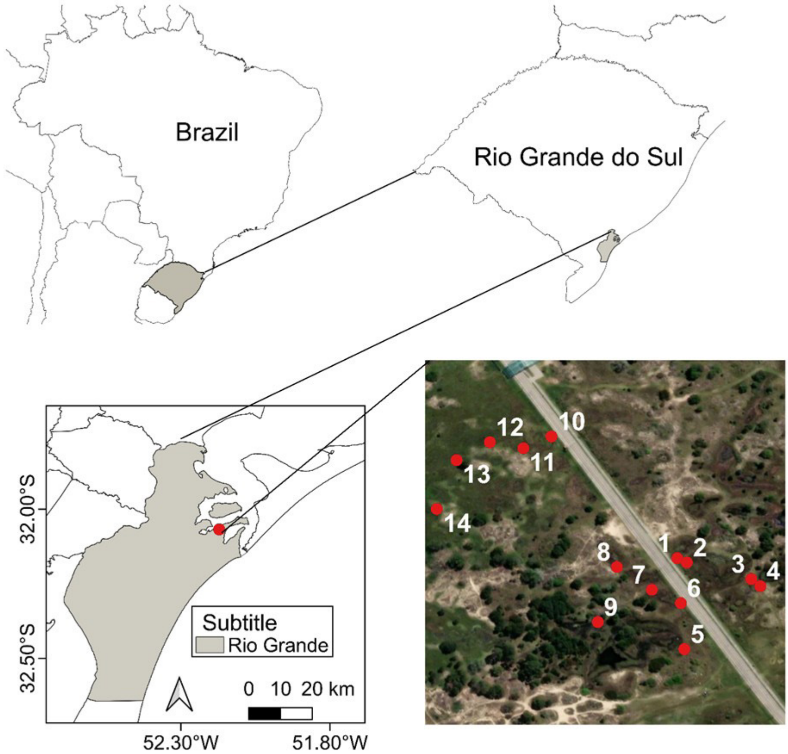


Figure 1. Study area temporary wetlands sampled (1-14) in the municipality of Rio Grande, Rio Grande do Sul, Brazil.

environments (Albertoni & Palma-Silva, 2010), resulting in rich aquatic ecosystems (Vieira & Rangel, 1988). The climate of the region is characterized as humid subtropical (Alvares et al., 2013), and the duration of the hydroperiods of temporary wetlands is variable (Martins et al., 2019).

The summer season in the region began in December 2023, extending until March 2024. Precipitation levels at the beginning of the season were sparse, with only 6.8 mm in December (Oleinski et al., 2025). Low accumulations were also observed in January (25.1 mm) and February (48.0 mm) of 2024, with the highest accumulated levels in March (74.8 mm) (Oleinski et al., 2025). The low rainfall caused drought during the period from December to early March, when some water depth began to form in the sampled locations. The total accumulated precipitation (mm) for the summer season indicated that the summer of 2023/2024 was the driest in the last 5 years (Figure 2).

2.2. Sampling

We calculated the area of the temporary wetlands using a Google Earth tool, by marking coordinates at five points around each sampled site. The depth (cm) was determined by three measurements at random points with a ruler. The limnological variables were measured with a Horiba® multiparameter probe by means of three measurements to obtain the values of: temperature (ºC), pH, dissolved oxygen (mg. L^{-1}), electrical conductivity (µS cm^{-1}), turbidity (NTU). We collected a sample of one liter of water to determine the concentrations of total nitrogen and total phosphorus according to protocols (adapted Mackereth et al., 1978; Baumgarten et al., 1996). All the procedures described above were performed for each of the fourteen environments sampled.

The invertebrates were collected at three random points in each temporary pond, totaling three replicates for each temporary nursery sampled. Data collection was performed using a D-net with a 250 µm mesh (Merrit & Cummins, 1996) through a sampling effort of 1 meter per repetition (Adapted from Li et al., 2024; Mera et al., 2023) by shaking the substrate and sweeping the disturbed area. The samples were packed in plastic bags and stored in a cooler with ice, where they were later sent to the laboratory. The samples were fixed in 80% alcohol with "rose bengal" dye and screened with the aid of a stereoscopic microscope. The invertebrates were counted and identified at the lowest possible taxonomic level based on specialized literature

(Merritt et al., 2008; Domínguez & Fernández, 2009; Trivinho-Strixino, 2011).

2.3. Data analysis

Principal Component Analysis (PCA) was used to order temporary wetlands based on limnological variables. To verify the frequency of occurrence of taxa (%) and frequency of total occurrence (%) of groups, we used the abundance data (n) available in supplementary material (Oleinski et al., 2025). To evaluate diversity, we calculated the richness and abundance of taxa (n), Shannon Index (H'), Simpson Dominance Index (1-D) and Pielou Equitability Index (J). To order the sampled areas according to the composition of taxa, we used the Nonmetric Multidimensional Scaling (NMDS) through the Bray-Curtis similarity Index based on abundance values and later we also performed a Hierarchical Cluster Analysis for the taxonomic composition of the sampled temporary wetlands based on Bray-Curtis. Statistical analyses were developed in the R software (R Core Team, 2024), using the '*vegan*', '*ggplot2*' packages.

3. Results

Our results showed that the temporary wetlands sampled varied in relation to the limnological variables (Oleinski et al., 2025). The area ranged from 70.8 to 336.0 m^2, and the depth ranged from 9.0 ± 0.04 to 36.0 ± 0.04 cm (Oleinski et al., 2025). The water temperature remained above 20.5 °C in the fourteen environments, reaching up to 29.7 ± 0.09 °C in TW6 (Oleinski et al., 2025). The most acidic sites were TW1 with a pH of 3.7 ± 0.12,

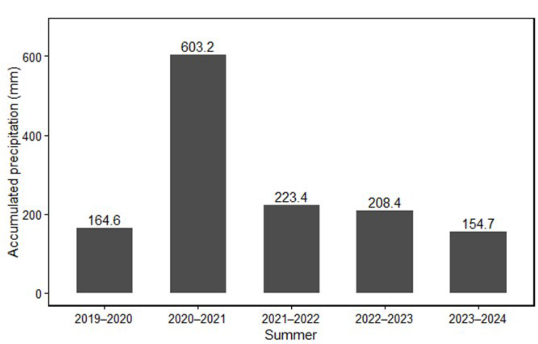


Figure 2. Accumulated precipitation (mm) values in the municipality of Rio Grande, RS, Brazil in the summers of the last five years in the municipality of Rio Grande, Rio Grande do Sul, Brazil. Data source: National Institute of Meteorology (INMET) and Permanent Council of Applied Agrometeorology of the State of Rio Grande do Sul (COPAAERS).

TW8 with a pH of 3.8 ± 0.40 and TW9 with 3.8 ± 0.10, while turbidity showed a high range of variation from 26.0 ± 8.22 to 207.3 ± 18.86 NTU (Oleinski et al., 2025). TW8 was shown to be the most oxygenated environment with a concentration of 9.1 ± 2.33 mg. L^{-1}, but on the other hand, TW13 and TW14 showed extremely low oxygen concentrations of 0.4 ± 0.11 and 0.5 ± 0.40 mg. L^{-1}, respectively (Oleinski et al., 2025). Electrical conductivity was low in the fourteen environments, ranging from 0.04 ± 0.02 to 0.25 ± 0.27 mS cm^2 (Oleinski et al., 2025). Nutrients ranged from 0.5 ± 0.05 to 2.4 ± 0.05 mg. L^{-1} for total nitrogen and 15.1 ± 1.40 and 64.7 ± 0.70 µg. L^{-1} for total phosphorus (Oleinski et al., 2025).

The first two axes of PCA (PC1 and PC2) jointly explained 48% of the total variation in the data, with 26% being explained by PC1 and 22% by PCA (Figure 3). The PC1 axis was mainly associated with the variables' temperature, pH, turbidity, and depth, while PC2 was associated with electrical conductivity, width, and total nitrogen (Figure 3). The highest nutrient concentrations (total nitrogen and total phosphorus) were correlated with environments TW12, TW13, and TW14 (Figure 3). For the same environments, dissolved oxygen showed a negative correlation (Figure 3). Areas TW3, TW4, TW5, and TW6 were most associated with the variables' temperature and turbidity (Figure 3).

A total of 3230 individuals were counted among the fourteen temporary wetlands sampled (TW1-TW14), distributed in 55 taxa (Oleinski et al., 2025). Among the taxa found, only *Belostoma* sp. occurred in fourteen environments, followed by *Polypedilum* sp. in thirteen sites (Oleinski et al., 2025). Eleven taxa, mostly Arachnida, were unique to specific wetlands (Oleinski et al., 2025). We highlight the high frequency of Collembola in TW12 (43.75%) and TW14 (49.56%), Cyclopoida in TW5 (34.21%), Planorbidae in TW12 (18.60%), TW13 (58.54%) and TW14 (23.92%), *Polypedilum* sp. in TW2 (35.12%) and Stratiomyidae in TW4 (60.58%) (Oleinski et al., 2025). Among the fourteen temporary wetlands sampled, Diptera was the most representative order (761 individuals), followed by the class Collembola (526 individuals) and the class Gastropoda (498 individuals) (Figure 4).

The diversity indices revealed that TW2 and TW5 were the environments with the highest richness (27 taxa), while TW9, TW10 and TW11 had the lowest, with 16 taxa respectively

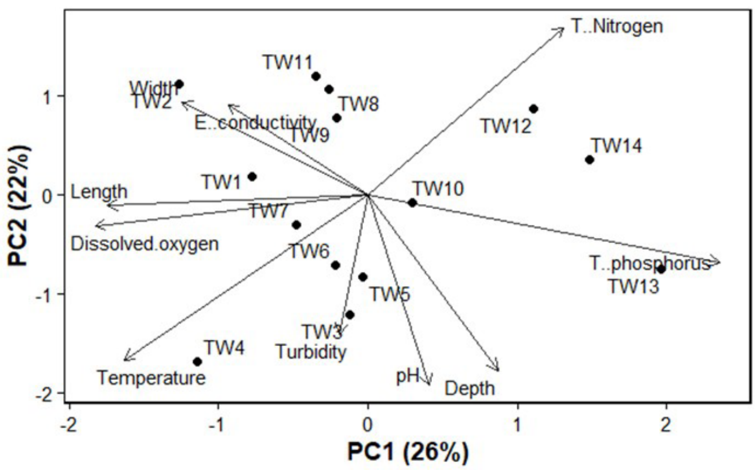


Figure 3. Principal Component Analysis (PCA) of limnological variables of temporary wetlands sampled in the municipality of Rio Grande, Rio Grande do Sul, Brazil, in March 2024. TW = Temporary wetland.

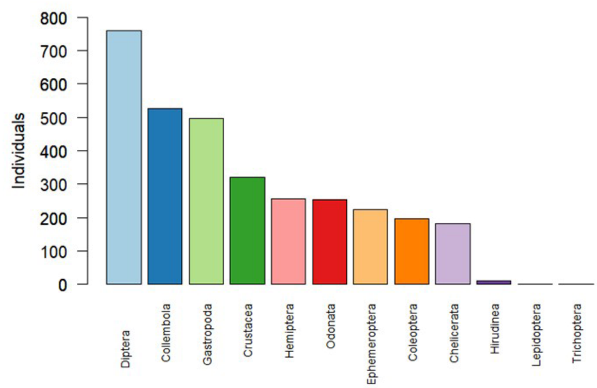


Figure 4. Most frequent orders and classes of aquatic invertebrates associated with temporary wetlands sampled in the municipality of Rio Grande, Rio Grande do Sul, Brazil, in March 2024.

(Oleinski et al., 2025). The abundance (n) varied among the fourteen sampled areas, reaching 678 individuals in TW12 and 40 in TW9 (Oleinski et al., 2025). The environments with the highest dominance (D) were TW4 and TW13 (0.38: respectively), while evenness (J) was higher in TW9 (0.94) and lower in TW13 (0.52) (Figure 5 and Oleinski et al., 2025). The Shannon index (H) indicated TW6 as the most diverse environment (2.65), while TW13 indicated the least diverse (1.48) (Figure 5 and Oleinski et al., 2025).

The non-metric scaling analysis (NMDS) indicated a trend for sorting into two main sets, with stress = 0.138 (Figure 6). The pattern obtained by the NMDS was confirmed by hierarchical grouping (Figure 6). The dendrogram indicates two main clusters, where the first was composed of temporary wetlands (TW) from 1 to 9, and the second cluster with areas from 10 to 14 (Figure 7).

4. Discussion

We observed that the temporary wetlands revealed a combination of small areas with low depths and high temperatures. The region of Rio Grande, RS was marked by a sharp drop in rainfall volumes, registering a long period of drought between December 2023 and early March 2024 (INMET, 2024), being the summer with the lowest accumulated precipitation (mm) in the last five years. Other researchers have been recognizing extreme drought events in the municipality of Rio Grande with anomalous values of less than 56.4 mm (Silva et al., 2019). However, information on temporary wetlands in the region is scarce (Martins et al., 2019), and it is not possible to infer how these environments are responding to changes in local climate.

A recent global study evaluating the influence of temperature and precipitation aspects on

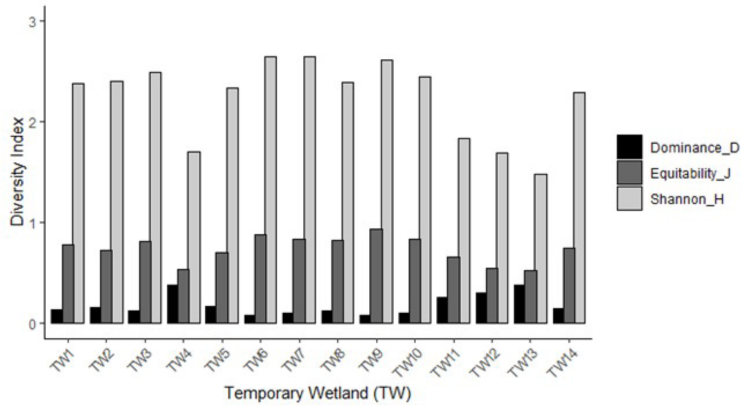


Figure 5. Diversity index: Simpson index (D). Shannon index (H') and Evenness index (J) of temporary wetlands sampled in the municipality of Rio Grande, Rio Grande do Sul, Brazil, in March 2024. TW = temporary wetland.

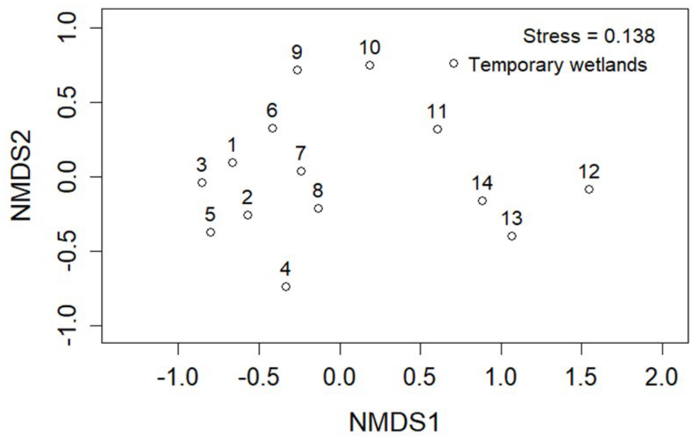


Figure 6. Non-metric Multidimensional Scaling (NMDS) of aquatic invertebrate abundance from temporary wetlands sampled in the municipality of Rio Grande, Rio Grande do Sul, Brazil, in March 2024. 1-14 = TW1-TW14.

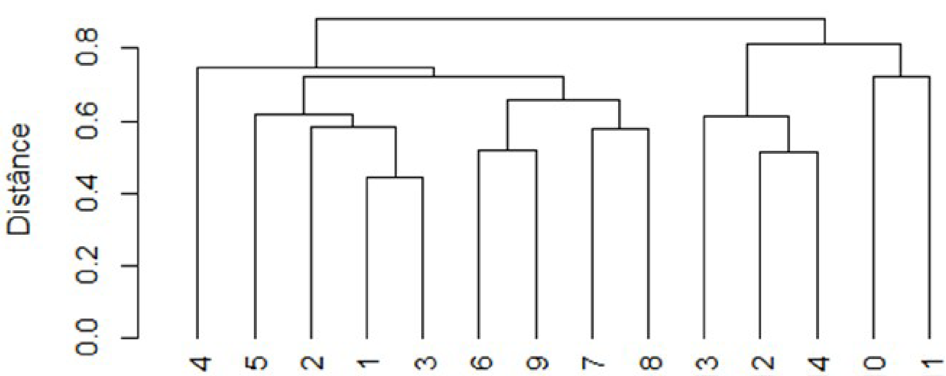


Figure 7. Cluster dendrogram of aquatic invertebrate abundance from temporary wetlands sampled in the municipality of Rio Grande, Rio Grande do Sul, Brazil, in March 2024.

invertebrate biodiversity concluded that the diversity of temporary wetlands is limited by the stressful relationship of warm environmental conditions and seasonal droughts, and that in taxon-poor communities, such changes may exceed the limit of sustained stress (Epele et al., 2022).

Other authors have pointed out that the effects of extreme events on invertebrate species richness are modulated by the magnitude that the variables reach and the frequency with which these events occur (Haubrock, 2024), and that the greatest impacts of climate change on invertebrates occur through drought (Collier et al., 2016). Thus, it is necessary to monitor temporary wetlands at the local and regional levels, considering that projections of higher amounts of drought events for the State of Rio Grande do Sul in the coming years (Cera & Ferraz, 2015), may generate effects on aquatic invertebrate communities.

The fact that the amplitude of environmental variables and extreme events are important predictors for determining the composition and distribution of aquatic invertebrate species, and that studies project an increase in severity in relation to climate change (Cai et al., 2014; Cera & Ferraz, 2015; Epele et al., 2022; IPCC, 2023), has been triggering studies on wetlands in this context (Parra et al., 2021; Haubrock, 2024; Machuca-Sepúlveda et al., 2024). Our results elucidated that temporary wetlands are an important habitat for aquatic invertebrates, which was reflected in the diversity of taxa (n=55) and in the number of individuals accounted for (n=3230), demonstrating that the sampled sites provide necessary niches for the species, and that there is an exclusivity of occurrence for some taxa in certain locations. A great diversity of insects associated with the evaluated environments was also verified, such as the one found by Pérez-Bilbão et al. (2015) also for temporary wetlands.

The results of the present study showed that the local factors (chemical and physical variables) of the temporary wetlands are important predictors for the grouping of aquatic invertebrate abundance data into two sets. These findings corroborate other studies, for example, researchers concluded that climatic variables, habitat complexity, and site depth are determinants of the composition of fauna in permanent and temporary wetlands (Bacca et al., 2021; Labat et al., 2024). Other studies for coastal wetlands found that environmental factors strongly imply variation in species composition, however, it was highlighted that there is no common dominance pattern between them (Hou et al., 2020).

However, in our study, the variables indicated that the second set formed by the TW10, TW11, TW12, TW13 and TW14 environments were characterized by environments with higher concentrations of nutrients and poor in oxygen. In addition, the set formed by these environments were predominantly colonized by Collembola and Planorbidae, especially in TW11, TW12 and TW13, which characterized these environments with high dominance and low species diversity. Our findings are similar to those of Cloherty & Rachlin (2011) for lakes, where different species of Planorbidae and Physidae were correlated to oxygen-poor environments. Furthermore, due to their morphological and physiological adaptations (*e.g.*, behavioral changes, resistance eggs, colonization of residual moist surfaces of the environment), Collembola are characterized by being resistant and tolerant to conditions of hypoxia and/or short and long hydroperiods (Marx et al., 2009, 2012). Thus, as observed in our study, springtails have a high frequency in different wetlands (Sterzynska et al., 2015; Batzer & Wu, 2020).

In this same context, among these temporary wetlands, we observed that TW12 presented the highest frequency of Collembola, and the presence, even with low frequency, of some taxa exclusive to Coleoptera, such as Staphylinidae and Torridincolidae. Although Staphylinidae beetles are predominantly terrestrial, their presence in temporary wetlands has been reported (Jeffries et al., 2016; Ahlén et al., 2024) but are however neglected by researchers. For this group of organisms, temporary wetlands serve as habitats, which is not considered entirely terrestrial or aquatic (Jeffries et al., 2016). The presence of Staphylinidae along with the high frequency of Collembola can be explained with the predation ability of Staphylinidae, in which the composition of its diet is mainly springtails, mites, and other invertebrates (Guan et al., 2025).

In our study, the order Diptera was the most representative among temporary wetlands. This pattern of occurrence is observed in other studies in different locations around the world (Ávila et al., 2011; Mlambo et al., 2011; Silver et al., 2012). This group forms an important link in the aquatic ecosystem between trophic levels, and are important invertebrates for recovery of the functional network after disturbances in these ecosystems (Cerba et al., 2023). In this context, among the Diptera, the Chironomidae can survive conditions of extreme desiccation, due to their distinct ecological characteristics of adaptations, physiological and behavioral strategies that guarantee their survival in different environmental conditions (Pacini and Harper, 2001; Montalto & Paggi, 2006).

Pacini and Harper (2001) points out that in temporary African wetlands, individuals belonging to *Chironomus*, *Polypedilum*, *Tanytarsus*, *Parachironomus* and *Labrundinia* are important representatives of chironomids that withstand desiccation conditions. In our study, we also observed that after an extreme drought event occurred in our study area, these chironomid genera were found, with *Polypedilum* being the most representative in some temporary ponds. One possible explanation is that to survive extreme drought conditions, *Polypedium* can construct tubes and cocoons for moisture conservation, which allows it to persist in dry sediment for many years (Montalto & Paggi, 2006).

On the other hand, few species can withstand the effects of desiccation (Williams, 2006). For this reason, aerial adults seek new habitats to colonize and deposit ovigerous masses in the water, and these sites are often close to each other (Batzer & Boix, 2016). For example, species of Hemiptera and Coleoptera typically only colonize wetlands if the hydroperiods are long (Vanschoenwinkel et al., 2010). In the dry phase in wetlands, these groups have a low frequency, due to their adaptation to having a migration mechanism (Williams, 1987), also explained by the length of their extended life cycle (Brendonck et al., 2017). As also observed by these authors (Williams, 1987; Vanschoenwinkel et al., 2010; Brendonck et al., 2017) in samples from wetlands, in our study it was no different, where Hemiptera and Coleoptera were found with lower frequencies (7.96% and 6.10%, respectively), possibly due to extreme drought.

Although the mesh of the collection net in this study is large (250 µm), a considerable number of microcrustacean individuals (Copepoda) could be observed, which mainly contributed to the Dominance Index D of TW5. These microcrustaceans are widely recognized for diapause (Bird et al., 2019; Martins et al., 2019; Vakati et al., 2023). Diapause is related to the occurrence of unfavorable environmental conditions or even to the drying of the environment, which allows these animals to remain in temporary humid areas (Williams, 2006; Bird et al., 2019), however, extreme drought conditions can reduce egg viability (Batzer & Boix, 2016). Like copepods, gastropods were also responsible for dominance, however, specifically in TW13 and TW14. These organisms have no active dispersal and lay their associated eggs on moist substrates to persist until drought (Batzer & Boix, 2016).

Other taxa such as *Baetis* sp. and *Caenis* sp. (Ephemeroptera) identified in this study, are considered ephemeral residents who do not have morphological adaptations to drought, who in turn, need to disperse from these places to survive drought events (Porst et al., 2012). But, at the same time, temporary wetlands are important breeding grounds for the reproduction and development of nymphs in this group. One of the reasons why aquatic invertebrates are associated with these environments is that temporary wetlands provide habitats distinct from permanent zones, so they support a specific faunal composition or even with high populations (Williams, 1997), being considered biodiversity hotspots due to their unique environmental characteristics (Parra et al., 2021). Furthermore, the non-occurrence of *Caenis* sp. and low frequency of *Baetis* sp. in the areas from TW10 to TW14, humid areas with high concentration of nutrients and low oxygenation, may be related to their high sensitivity and intolerance to environmental conditions, since the ephemerals are considered good biological indicators of environments with environmental disturbances (Da-Silva & Salles, 2024).

The temporary wetlands in this study support an important diversity of invertebrates, serving as a foraging and resting place also for facultative species that migrate to other environments (Boix et al., 2020). For these environments, the eventuality of the occurrence of rainfall and drought seem to generate a balance for the establishment of invertebrates, however, imbalances in this relationship can generate cascading effects in these organisms, since many species follow the environmental variation of these places (Epele et al., 2024). The correlation between the small size and temporality of the hydroperiods of temporary wetlands makes these environments vulnerable to climate change, where changes in temperature and precipitation patterns generate several effects (Boix et al., 2020), which can affect the diversity of aquatic invertebrates (Renton et al., 2015). Still, it is important to note that climate change is still happening, and that as the global climate continues to change, temporary ponds are susceptible to biodiversity loss in regions where the frequency of drought events increases (Anton-Pardo et al., 2019). Thus, assessing invertebrate associations at different environmental scales may be a key factor in understanding what effects climate change may have on wetlands (Epele et al., 2024).

5. Conclusion

Climate change projections indicate an increase in frequency and potential for severe drought events. These events will affect temporary wetlands that are vulnerable due to their size and their relationship to hydroperiods. Environments have an important diversity of aquatic invertebrates, and their monitoring is a crucial factor in identifying how these temporary wetlands are responding to extreme events. The fourteen temporary wetlands analyzed in our study were reflected in two sets of sites, with the predominance of Diptera and Gastropoda for both sets of sites. However, in one of the sets, characterized by wetlands from TW10 to TW14, there were environments with higher concentrations of nutrients and low oxygen contents, which resulted in the predominance of Collembola and Planorbidae.

Severe drought events can affect the composition and distribution of species, requiring the monitoring and protection of temporary wetlands. Our study is one of the pioneers in temporary wetlands that seeks to understand the composition of aquatic invertebrates after a drought event in Southern Brazil and provides excellent insights into invertebrate biodiversity at these sites to assist in conservation measures of local biodiversity hotspots. Future studies should seek to compare the composition of aquatic invertebrates at times before, during and after extreme drought events, as well as to evaluate whether environmental characteristics resulting from such circumstances or other consequences of climate change (*e.g.,* floods and/or anthropogenic influence) interfere with the faunal composition of these and other organisms in temporary wetlands.

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Data availability

The authors declare that the research data supporting the findings of this study have been published in the article itself. In addition, if necessary, upon request, the authors will provide the research data separately from the article. All supplementary data is freely available in the SciELO Data repository, in the following link: https://doi.org/10.48331/SCIELODATA.FLZLPS.

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