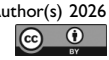
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Centralized hashtags, embedded discourse: Two structural logics of youth climate activism on social media

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Abstract

Youth-led climate action increasingly unfolds on digital platforms, where hashtags structurally connect issues, actors, and publics. Using hashtag co-occurrence data (2022–2024) from prominent youth climate activists on X and Portuguese youth climate activists on Instagram, this study applies link community analysis, which captures overlapping multimembership structures that node-based clustering obscures. Two contrasting structural logics emerge. The international network exhibits a centralized configuration in which core climate hashtags such as #FridaysForFuture and #Peoplenotprofit occupy bridging positions across issue communities, so that visibility and structural centrality closely align. The Portuguese network displays a more horizontal configuration in which climate-related hashtags co-occur with feminism, education, domestic politics, and art-based activism, embedding climate discourse within everyday publics. Digital climate publics take shape as relational structures produced through patterns of hashtag overlap and cross-issue connectivity.

Keywords

climate change, hashtag, link community analysis, social network, young activism

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Introduction

Youth-led climate action increasingly unfolds through digital platforms, where social media provides infrastructures for visibility, mobilization, and public engagement. Networked communication environments extend collective action beyond traditional organizational structures, enabling decentralized participation across geographical and cultural boundaries (Bennett, 2003; Kelly, 2006; Hautea et al., 2021). Within these environments, communicative practices shape the dynamics of collective action. Social media enables emotional expression and circulation of shared concerns and supports the formation of networked publics organized through digitally mediated discourse (Papacharissi, 2015). Such processes embed individual participation within broader mobilization ecologies (Cardoso et al., 2016), positioning communication as a central mechanism of public formation and coordination. Hashtags play a particularly important role in this process. Through co-occurrence relations, they connect issues, actors, and discourses across multiple domains of public life. These connections extend climate communication beyond environmentally bounded discussions and contribute to broader configurations of issue publics. Understanding how such connectivity emerges is central to explaining the formation of digital climate publics.

Existing research has generated substantial knowledge on digital climate activism, including framing processes, emotional expression, participation, and mobilization (De Moor et al., 2019; Mattoni and Treré, 2014; Papacharissi, 2015; Wallis and Loy, 2021). However, less attention has been paid to the structural mechanisms through which hashtags connect multiple issue domains and sustain overlapping publics. This limitation is partly related to dominant node-based clustering approaches, which prioritize discrete community boundaries. While these methods capture thematic organization, they are less effective in representing overlap and intersection, despite climate discourse rarely developing within isolated spheres. Addressing this requires analytical approaches capable of identifying multi-membership structures and cross-community connectivity.

This study addresses this gap by applying link community analysis to hashtag co-occurrence networks of internationally prominent youth climate activists on X and Portuguese youth climate activists on Instagram. Unlike node-based clustering, link community analysis captures overlapping community structures and reveals how hashtags simultaneously participate in multiple issue publics. The analytical focus therefore shifts from thematic categorization to relational architectures of digital climate publics.

Youth climate activism on digital platforms: from transnational to local

Digital platforms function as central arenas in which climate stakeholders compete for discursive authority. Transnational networks such as Fridays for Future and globally oriented opinion leaders frame climate change as a global emergency that mobilizes universal moral responsibility across national boundaries (De Moor et al., 2019; Olausson, 2009). Compared with established environmental organizations, youth-led groups deploy crisis sentiment and moral appeals more effectively, achieve higher visibility, and occupy

more central positions in cross-border issue diffusion (O'Neill, 2017; Segerberg and Bennett, 2011). Globally visible youth activists also operate as connective leaders (Poell et al., 2016; Ratta and Valeriani, 2012): Greta Thunberg seeded personalized pathways that scaled into Fridays for Future (Molder et al., 2022), and celebrities such as Mark Ruffalo amplify shared frames by referencing fellow participants (Thorson et al., 2016).

Existing scholarship also points to structural asymmetries in the linguistic and geographic distribution of youth climate discourse. A Twitter-based analysis of Fridays for Future communication finds that English, French, and German content anchors the network, while Spanish remains peripheral despite its global reach (Padilla-Castillo and Rodríguez-Hernández, 2023), reflecting the orientation of Spanish activists, especially in Barcelona, toward local contexts (Terren and Soler-i-Martí, 2021). Portuguese activism shows a comparable localization tendency. As a country on the frontline of climate risk, Portugal provides a setting in which youth groups such as Greve Climática Estudantil link global climate change to national crises including wildfires, droughts, and energy policy debates (Carvalho et al., 2017).

Taken together, these findings reveal a contrast between transnationally oriented youth activism that operates through globally shared frames and locally grounded activism anchored in domestic political and ecological realities. However, understanding the structural mechanisms that shape these different configurations of youth climate publics requires attention to how hashtag practices organize cross-issue connectivity across contexts.

Hashtags, platforms, and the constitution of digital publics

Hashtags operate as metadata that structure the circulation of content and facilitate interaction around social issues, events, and political action (Caliandro, 2018). Each hashtag constitutes a distinct communicative event whose form and content emerge from the actors who participate (Rambukkana, 2015). Online climate exchanges, for example, often branch from #climatechange into specialized tags that track international negotiations (#COP), amplify youth participation (#COY), or emphasize crisis framing (#climatecrisis), with users combining multiple hashtags to reach overlapping audiences.

Through these practices, hashtags actively constitute publics. The topic-based networks they generate warrant analytical distinction from pre-existing follower networks (Rambukkana, 2015), although the two layers interact when users enter topic communities through replies or reposts (Bruns and Moe, 2014). This public-forming capacity sits at the core of the connective action model, in which digital movements rely on transmissible communicative objects, including hashtags, that support heterogeneous yet interconnected mobilization (Bennett and Segerberg, 2012; Benkler, 2006). The meanings circulating through these acts coalesce into networked frames sustained by collective use (Meraz and Papacharissi, 2013; Papacharissi, 2015).

Beyond linking posts, hashtags render discourse searchable, enabling users to find and connect with others discussing the same topic without requiring direct interaction or mutual following (Zappacigna, 2011). Through this form of "ambient affiliation,"

hashtags facilitate encounters among users through shared tags, allow users to search for issue-related hashtags, and provide a means of gaining visibility among fellow activists and signaling how posts should be interpreted (Zappavigna, 2015). In this sense, hashtag co-occurrence captures structural traces of the connective work through which publics centered on different issues become linked to one another.

Although hashtags perform comparable technical functions across platforms, their concrete implementations are shaped by platform-specific affordances and user cultures (Bucher and Helmond, 2018; Dean, 2019; Leaver et al., 2020). Text-oriented environments such as X and image-oriented environments such as Instagram offer different architectures of visibility and engagement, which condition how hashtags circulate and accumulate meaning (Bossetta, 2018). Within visual social media environments, memes and multi-tagged posts construct navigable, non-linear structures of communication (Highfield and Leaver, 2016; Rathnayake and Suthers, 2021).

Nested publics and cross-issue connectivity in climate communication

The constitutive capacity of hashtags becomes particularly consequential in climate communication, where issues rarely circulate within bounded thematic spheres. Rathnayake and Suthers (2025) introduce the notion of nested publics to describe how cross-domain discourse flows emerge when hashtags operate simultaneously across multiple topic communities, so that individual hashtags participate in several discursive arenas at once and the publics they convene overlap and intersect rather than occupying mutually exclusive positions.

Empirical work suggests two prominent directions in which nested publics develop around climate. The first runs through everyday life and popular culture, where young participants juxtapose climate hashtags with lifestyle, consumption, or entertainment tags driven by identity expression and algorithmic visibility (Boykoff, 2019; Hautea et al., 2021), bringing climate issues into media environments consistent with the domestication of grand issues (Bennett, 2012). The second runs through structural political critique. Activists increasingly read the climate crisis through global capitalism, colonial legacies, and systemic inequality (Fisher, 2019), so that climate hashtags appear alongside tags of social justice and gender equality, producing an intersectional discourse in which climate functions as a master frame (Benford and Snow, 2000; Della Porta and Parks, 2014).

Although this literature establishes that climate publics extend beyond single-issue boundaries, two limitations remain. First, existing work characterizes overlap and nesting at the level of discourse or thematic content, with limited systematic attention to how multi-membership structures emerge through shared network ties, despite overlap being a defining feature of the climate discursive field. Second, empirical research has concentrated on English-speaking contexts and internationally prominent actors, leaving youth climate communication in non-English-speaking contexts (Boykoff, 2011; Schäfer et al., 2014), and particularly Southern European settings underexamined.

Therefore, this study conceptualizes the digital climate public as a nested public that takes shape through structural connections within multi-issue networks rather than through a single label. To capture this multiplex structure, the study adopts link community analysis (Ahn et al., 2010), a method that treats communities as clusters of links and allows individual hashtags to belong to multiple overlapping communities simultaneously. This analytical move renders visible the cross-issue connective work that single-membership clustering tends to obscure. From a structural perspective, the analysis focuses on organizational forms and relational patterns within digital climate communication, rather than solely on content or mobilization outcomes. By examining social media content produced by prominent youth climate activists and drawing on Portuguese local youth climate action as a comparative case, the study analyzes differences in digital climate communication structures at international and local levels. Three research questions guide the analysis:

1. How do internationally prominent and local Portuguese young climate activists employ hashtag practices to construct cross-issue linkages in digital communication?
2. What structural patterns of cross-issue connectivity emerge from these practices?
3. How do these patterns shape the formation and organization of youth climate publics online?

Method

Data collection and cleaning

This study focuses on two groups of young climate activists. The first group consists of prominent activists who participate actively in international climate events, such as COP and COY. The second is composed of young Portuguese climate activists who exert a stronger influence at the national level than internationally. The analysis examines each group on the platform that serves as their primary site of climate communication. Prominent youth climate activists are most active in their climate-related communication on X (formerly Twitter), which has emerged as a key arena for issue diffusion, policy debate, and the circulation of current-events content among internationally oriented climate stakeholders (Padilla-Castillo and Rodríguez-Hernández, 2023; Segerberg and Bennett, 2011). Portuguese youth climate activists, by contrast, conduct their climate communication primarily on Instagram, which emphasizes visual expression and has developed into a socio-political space dominated by young users (Leaver et al., 2020). Preliminary observation confirms that their use of X remains minimal within this group.

The two groups are observed on the platforms where they are most active, and the study treats actor context and platform affordances as co-constitutive features of hashtag practice rather than as independently observable variables. The goal of the comparison is to characterize how hashtag networks take shape in the environments where each public actually forms. Where structural differences emerge between the two networks, they are interpreted as the joint outcome of activist strategy and platform affordance, an

interpretation consistent with research showing that platforms and communicative practices are mutually shaping (Bossetta, 2018; Bucher and Helmond, 2018).

The two lists of activists were compiled according to Google searches, references from the United Nations, and major media outlets. To ensure the inclusion of only high-profile figures on X, the study considered activists with more than 20,000 followers (see Appendix). Although none rival Greta Thunberg in terms of global visibility, several maintain substantial influence among youth audiences and continue to attract media attention. The Portuguese sample includes both youth-led organizational accounts (such as Greve Climática Estudantil Lisboa and Climáximo) and individual activist accounts (see Appendix). These two types of accounts are treated as equivalent units in this study, because youth-led organizations in Portugal operate horizontally rather than through formal institutional hierarchies. Their accounts are typically managed and voiced by young activists themselves rather than by professional communication staff. In terms of hashtag use, both organizational and individual accounts function as communicative voices within youth-led climate activism and contribute to the same online conversation.

All publicly available posts published by these accounts between January 1, 2022, and December 31, 2024, were collected using Zeeschuimer and 4CAT. In total, 2628 posts from X and 2045 posts from Instagram were retrieved, and all hashtags were extracted. Before constructing the network, the study first conducted a statistical analysis of hashtag frequencies to assess potential differences in the occurrence and function of high-frequency and navigation-oriented hashtags across the two groups. To focus on shared discourse rather than isolated activity, all nodes belonging to independent micro-communities were excluded. The final X network contains 202 hashtags (nodes) and 511 co-occurrences (edges), while the Instagram network contains 372 hashtags (nodes) and 1732 co-occurrences (edges).

Data analysis

Hashtag co-occurrence networks can be understood as discursive maps in which connections among hashtags reveal the navigable architecture of issue references (Caliandro, 2018; Rathnayake and Suthers, 2025), with the social media post operating as a semantic bridge between co-occurring tags. Conventional node-based community detection partitions hashtags into mutually exclusive subgraphs and therefore obscures the cross-issue connective work that hashtags perform when they participate simultaneously in several thematic clusters. To capture this multiplex structure, the study applies link community analysis (Ahn et al., 2010; Evans and Lambiotte, 2009; Kalinka and Tomancak, 2011), which redefines communities as clusters of links and allows individual hashtags to belong to multiple overlapping communities at once. This approach therefore renders visible the structural topology of discourse networks, including community nesting, overlap, and bridging nodes, and complements semantic and discursive analyses by foregrounding how climate discourse circulates across interconnected thematic domains.

Network construction and analysis were implemented in Python 3.13.1 using NetworkX for graph manipulation, NumPy for numerical operations, and SciPy's

hierarchical clustering module. For each pair of edges, similarity was computed as the Jaccard coefficient of their inclusive neighborhood sets, defined for an edge (u, v) as the union of the neighbors of u, the neighbors of v, and the two endpoints themselves. The resulting edge similarities were converted into a distance matrix (one minus similarity) and clustered hierarchically using average linkage. The distance threshold for cutting the dendrogram was selected through a parameter sweep from 0.30 to 0.94 in increments of 0.02. For both networks, the unconstrained maximum of overall partition density occurred at $t = 0.30$, but this produced 228 link communities for the international network and 146 for the Portuguese network, with most communities containing only 2–4 hashtags and therefore offering limited interpretive traction. As Ahn et al. (2010) note, partition density operates as a guide rather than a strict optimization target, and prior work has emphasized the trade-off between algorithmic optima and interpretive granularity in community detection (Fortunato, 2010). The threshold was therefore selected from the stable plateau region in which overall partition density varied minimally with threshold choice. In both networks, this plateau extended from approximately $t = 0.62$ to $t = 0.78$, with partition density fluctuating within a range of 0.015 for the international network and 0.013 for the Portuguese network. Within this plateau, $t = 0.70$ was adopted as the final cutoff, yielding 105 link communities for the international network (overall partition density = 0.377) and 97 for the Portuguese network (overall partition density = 0.286), values consistent with those typically observed in real-world hashtag networks. The full sweep curves are reported in the supplementary material.

The analysis then proceeded at three levels. First, the link community partition was inspected to identify thematic clusters of co-occurring hashtags within each network. Second, community centrality was computed for each hashtag following Kalinka and Tomancak (2011): for a node belonging to k link communities, the score is defined as $1 + (2/k) \times \Sigma(1 - s)$, where s denotes the Jaccard similarity between the node sets of each pair of those communities. This measure captures the extent to which a hashtag bridges structurally distinct issue communities, with higher values indicating more pronounced cross-community linkage. Third, nested link communities were identified at a higher level of aggregation. Pairs of link communities were treated as thematically intertwined when they shared at least three hashtags, a threshold chosen to filter out incidental overlaps while retaining substantively connected community pairs. Connected components of the resulting meta-network of intertwined community pairs were treated as nested link communities, representing higher-order clusters of co-occurring thematic structures.

Results

Hashtag frequencies

Figure 1 and Figure 2, respectively, show the hashtags frequently used by two groups of youth climate activists on social media over a two-year period. Among famous young climate activists, #FridaysForFuture emerges as the most used hashtag, followed by those associated with international climate conferences, such as #COP27, #COP28, and

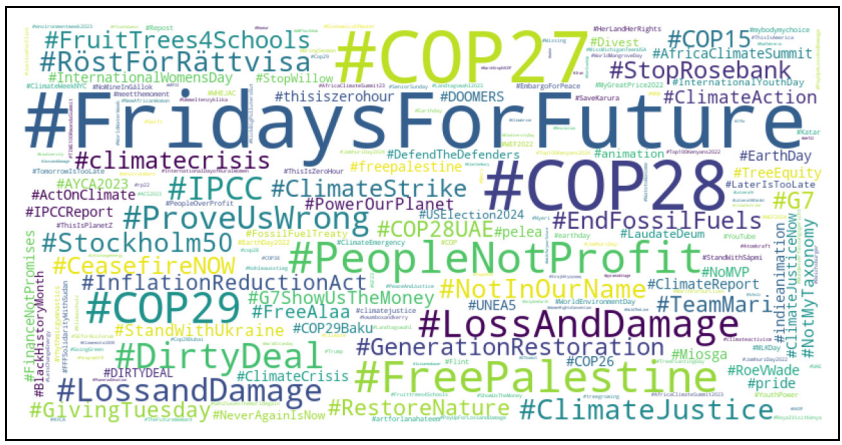


Figure 1. Hashtag word cloud of prominent youth climate activists on X.

#COP29. Other frequently occurring hashtags include slogans widely circulated in youth climate movements, such as #Peoplenotprofit, #LossandDamage, #DirtyDeal, and #ProveUsWrong. Moreover, #FreePalestine is not only widely used among prominent young climate activists on X but also occupies a significant position among young Portuguese activists.

On Instagram, #endfossil and #fimaofossil occupy prominent positions; the two tags carry equivalent meanings in English and Portuguese, respectively. In addition, hashtags such as #geveclimaticaestudantil, #climatejustice, #studentuprising, #FazPeloClima, and #acampamento1ponto5 are also more frequently used within this group.

Link communities

Link community analysis shows that the network of prominent young climate activists includes 105 induced node communities, and Portuguese grassroots young climate activists have 97 induced node communities. Figures 3(a) to (e) and 4(a) to (e) visualize selected communities to demonstrate how labels permeate multiple thematic clusters. For prominent young activists, as presented in Figure 3, #COP27, #Freealaa, and #Freethemall contribute to clusters (b) and (e). Although these hashtags appear in both clusters, each cluster has a distinct orientation. Thematic cluster (b) emphasizes topics related to climate politics and includes hashtags such as #COP28, #COP15, #Globalwomensummit, #Whoguidelines, and #Wmfyouthhub. This cluster also references #Biodiversity, #Letschangeenergy, and #Nomorefossilfuels, indicating a broader set of tags associated with COP conferences and international negotiations. Cluster (e) likewise contains tags such as #COP27 and #Freethemall, but places greater emphasis on climate-justice discourse through tags such as #Climatejustice, #Climatejusticenow, #Radicaljustice, #Nomoresacrificezones, #Womenrightconvention, and #Climateequality. Additional tags such as #Dirtydeal and #MakePollutersPay further

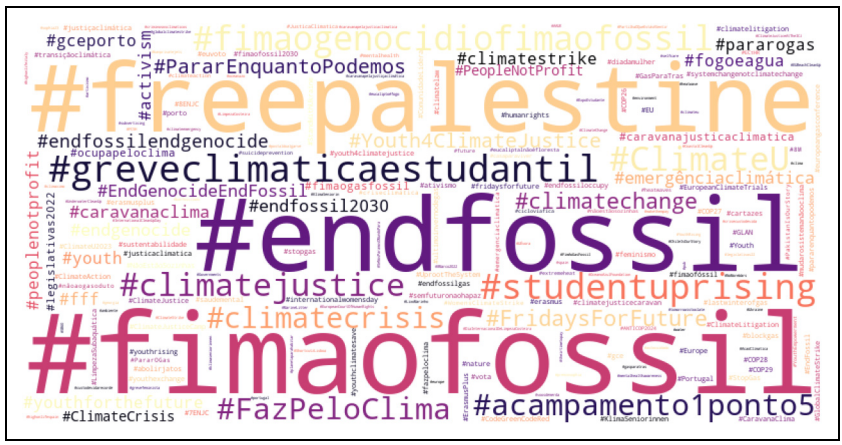


Figure 2. Hashtag word cloud of Portuguese youth climate activists on Instagram.

direct attention to fossil-fuel trade within this cluster. Figure 3 also shows that #Nomoresacrificezones appears in both clusters (d) and (e), where cluster (d) focuses specifically on opposition to fossil-fuel expansion plans. Although #COP27 appears in clusters (a) and (e), multiple shared tags also span clusters (d) and (e). Consequently, users can navigate distinct content streams through hashtags operating across multiple clusters.

A similar pattern is evident in the hashtags employed by local youth activists in Portugal. For example, the tags #heatwave, #extremeheat, #noplanetb, #climateemergency, and #youthclimate appear in both clusters (c) and (e), yet cluster (c) focuses on extreme weather and climate crisis, while cluster (e) emphasizes climate litigation and legal action. This pattern indicates that hashtags spanning multiple thematic clusters help unify discourse by interweaving different thematic domains. Conceptually, these thematic clusters exhibit polymorphic characteristics, reflecting multiple orientations within the issue-response network (Rathnayake and Suthers, 2025). Against this backdrop, the hashtags that span multiple clusters play a pivotal role in guiding multiple distinct thematic clusters, demonstrating their capacity to serve as conduits connecting these clusters and thereby unifying discourse.

Some hashtags appeared across both the group of prominent youth and the group of Portuguese youth, indicating overlapping discursive space between the two scales of climate activism, such as #FridaysForFuture, #Climatestrike, #Peoplenotprofit, #Climatejustice, #Endfossil, and #Climateemergency. In the link community structure, these overlapping hashtags function as bridging nodes that connect otherwise distinct thematic clusters, facilitating both the adoption of global discourse frameworks by local Portuguese actors and the dissemination of local discourse within international conversations.

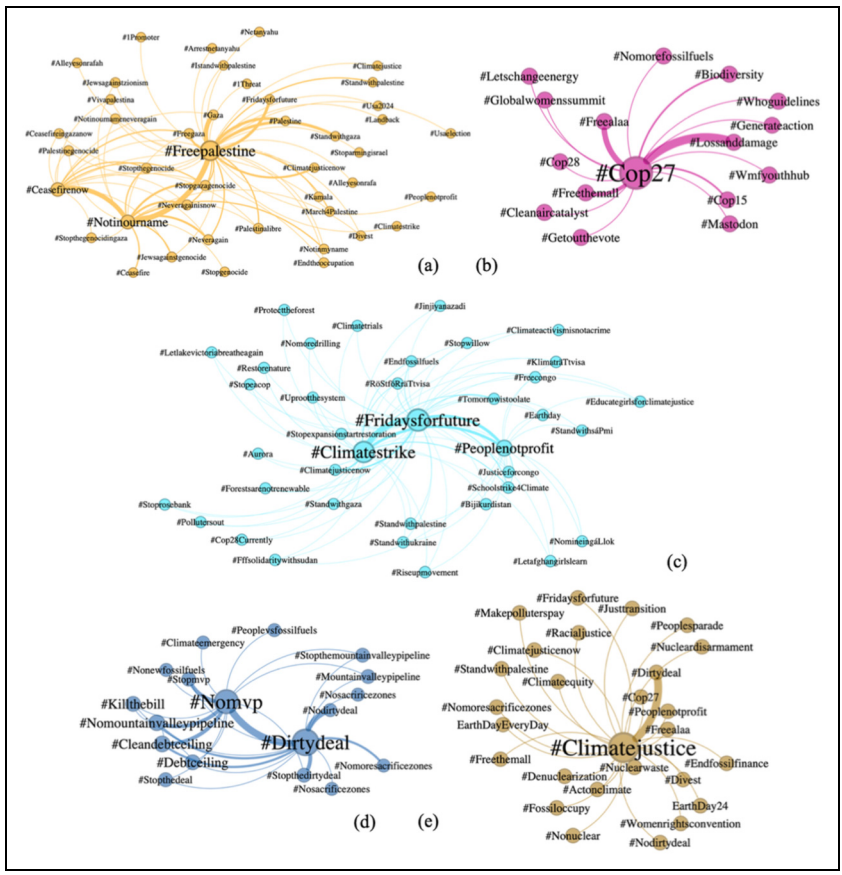


Figure 3. Thematic clusters on X. Five clusters with different topical orientations: (a) anti-genocide in the Palestinian–Israeli conflict, (b) COPs and international negotiations, (c) the global climate movement and the transnational justice coalition, (d) opposition to fossil fuel plans and legislative compromise, and (e) institutional justice.

Community centrality

Community centrality is a measure of centrality that weights the number of linked communities to which a given node belongs, based on the distinctiveness of those communities relative to one another (Kalinka and Tomancak, 2011). This measure indicates the extent to which individual hashtags connect across multiple communities (thematic clusters). A value of 0 denotes that a node belongs to no linked community, a value of 1 indicates membership in a single community, and higher values represent simultaneous affiliation with multiple distinct communities. Table 1 and Table 2 show an overview of community centrality values and hashtag popularity (frequency of use) for some key nodes. A notable observation was the absence of high centrality of certain high-frequency hashtags (e.g., #FridaysForFuture and #COP28 on X, #fimaofossil and

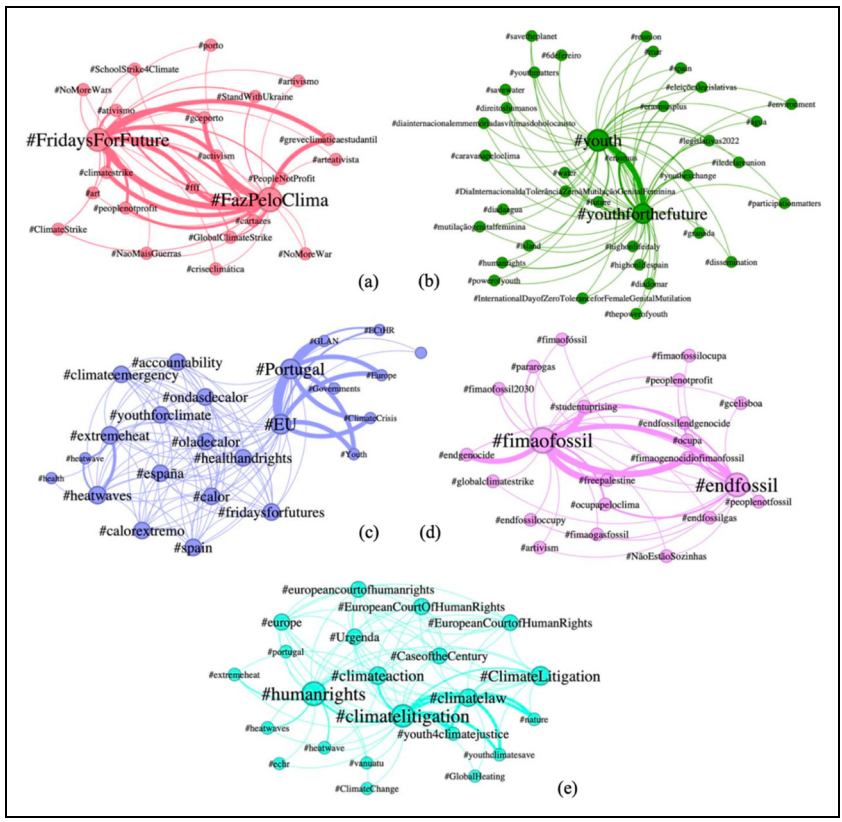


Figure 4. Thematic clusters on Instagram. Five clusters with different topical orientations: (a) student walkouts and local actions, (b) youth empowerment and education, (c) extreme weather and climate crisis, (d) against fossil fuels, and (e) climate litigation and legal action.

#endfossil on Instagram) within their respective communities on both platforms. Despite their widespread use, these tags have not become key "hubs" for information flow and do not navigate discussions or guide them toward other topic areas. Their role is closer to that of "general vocabulary" than "structural hubs."

Within the networks of prominent young climate activists, certain frequently used hashtags also exhibit high centrality, such as #COP27, #Peoplenotprofit, #Dirtydeal, and #Ipcc. This subset combines high visibility with strong bridging functions, connecting otherwise distinct communities within the network. More broadly, however, usage frequency and structural centrality do not necessarily align: many of the most frequently used tags remain peripheral to the network's connective structure, as noted above.

Nested communities: intertwined thematic cluster structures

Nested link communities represent thematic clusters in which two topics are intertwined. The analysis of the group of prominent young climate activists produced 70 nested

Table 1. Community centrality values (ComC) and frequency of hashtags on X.

Hashtags	ComC	Hashtags	Frequency
#Peoplenotprofit	4.627	#FridaysForFuture	85
#Nodirtydeal	4.574	**#COP27**	73
#Dirtydeal	3.807	#COP28	68
#COP27	3.793	#COP29	18
#Standwithpalestine	3.769	#FreePalestine	18
#Standwithgaza	3.709	**#Peoplenotprofit**	17
#Climatejusticenow	3.664	#LossAndDamage	21
#Nomoresacrificezones	3.648	**#Dirtydeal**	11
#Endfossilfuels	2.918	#ProveUsWrong	9
#Ipcc	2.898	**#Ipcc**	9

Table 2. Community centrality values (ComC) and frequency of hashtags on Instagram.

Hashtags	ComC	Hashtags	Frequency
#FridaysForFuture	6.479	#fimaofossil	86
#criseclimática	6.452	#endfossil	63
#endfossiloccupy	6.370	#freepalestine	47
#mudarosistemanãooclima	5.644	#greveclimaticaestudantil	43
#peoplenotprofit	5.538	#studentuprising	42
#fff	5.483	#fimaogenocidiofimaofossil	39
#gceporto	5.483	#ClimateU	34
#globalclimatestrike	5.462	#climatejustice	34
#ambiente	5.452	#acampamento1ponto5	33
#ativismo	5.450	#FazPeloClima	32
#justiçaclimática	5.435	**#ClimateCrisis**	31
#youth4climatejustice	5.293	**#FridaysForFuture**	31
#ClimateCrisis	5.063	#climatechange	31

communities and 54 nested communities among Portuguese young climate activists, showing a diverse set of local nested thematic structures. Edges for each cluster are visualized in different colors. Gray nodes belong to only one community within the displayed nested communities, while colored nodes serve as bridge nodes between two communities.

For prominent young climate activists, the analysis identified three general orientations of nested communities: (1) climate change-specific topics embedded within broader non-climate macro-thematic frameworks, (2) different climate-related issues nested within one another, and (3) broad climate frames encompassing more specific climate sub-topics. Figure 5 shows one example of each orientation in turn. Figure 5(a), illustrating the first orientation, shows hashtags related to the Gaza issue (#CeaseFireNow, #FreePalestine, #StandWithGaza) alongside discussions of #Climatejusticenow and #FridaysforFuture, linking climate justice with human-rights justice. Figure 5(b) depicts

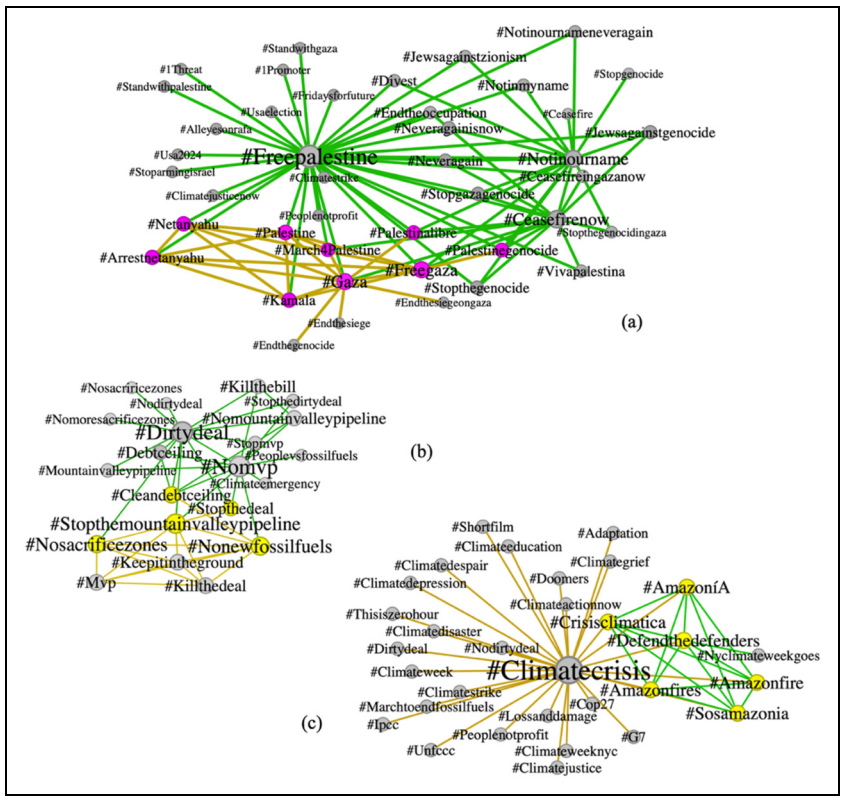


Figure 5. Nested cluster structures of prominent young climate activists. The figure shows three nested communities: (a) Gaza, humanitarian catastrophe, and climate justice, (b) policies opposing the expansion of fossil fuel projects and dirty deals, and (c) climate crisis, COPs, and Amazon.

a set of hashtags linking opposition to fossil fuel infrastructure development at the expense of community and climate goals (#DirtyDeal, #NoMVP, #StopTheDeal), alongside fossil fuel concessions engineered in US debt ceiling negotiations (#DebtCeiling, #CleanDebtCeiling), to the narrative of the climate emergency (#ClimateEmergency, #PeoplevsFossilFuels). The tags depicted in Figure 5(a) and (b) demonstrate a pronounced political inclination. Figure 5(c) nests overarching climate change narratives, such as #ClimateCrisis and #COP, alongside more specific climate-related events, including concerns surrounding the Amazon (#AmazoníA, #Amazonfire, #Sosamazonia), thereby embedding broader climate anxieties within concrete issue contexts.

Among Portuguese young climate activists, Figure 6(a) and (c) show youth climate activism topics embedding cross-thematic hashtag clusters, such as topics of artivism (#artivismo, #arte, and #arteativista), feminism (#feminismo, #mulheresigualdade, and #8M2022), and political (#politica, #chega, and #politicaportuguesa). Figure 6(b) and (d) embed specific climate-related issues, such as anti-fossil fuel (#fimaofossil,

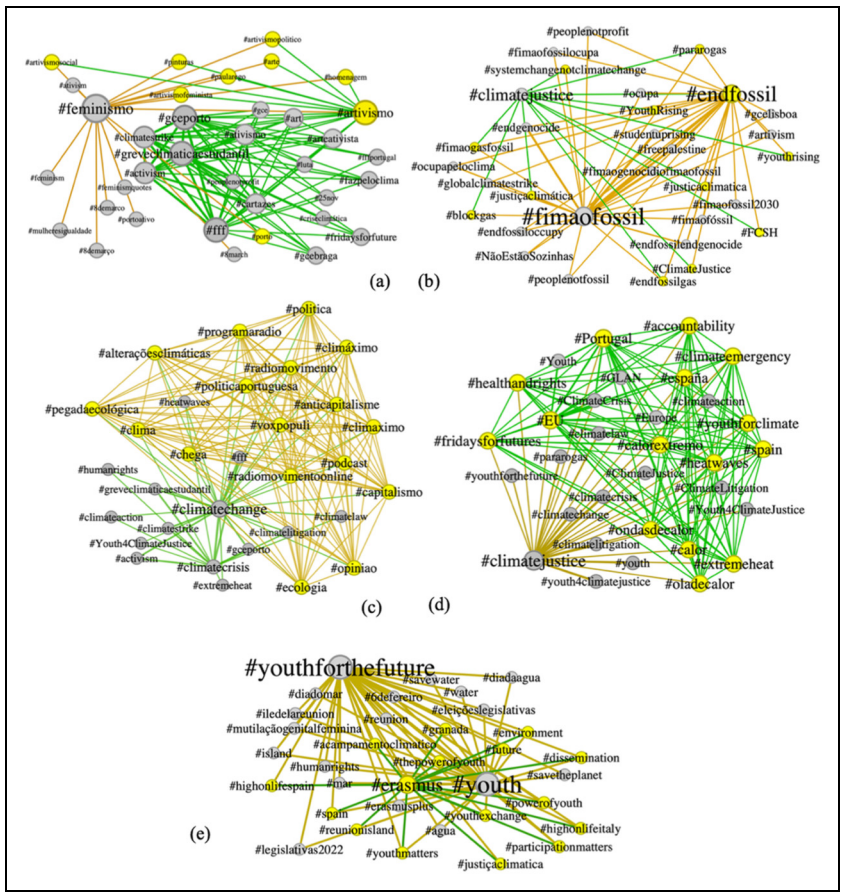


Figure 6. Nested cluster structures of Portuguese young climate activists. The figure shows five nested communities: (a) youth activism, feminism, and art, (b) anti-fossil fuel, (c) political and youth initiatives, (d) extreme weather, transnationalism, and youth, and (e) youth education and international exchange.

#endfossil, and #endfossilgas), and extreme weather (#heatwaves, #calor, and #calorextremo), within the broader theme of climate change. In contrast to the group of prominent young climate activists, the hashtags network of Portuguese young climate activists shows no evidence of nested community structures organized around leading climate change thematic hashtags. However, Figure 6(e) shows youth climate activism hashtags binding together daily hashtags to form thematic clusters, such as topics of youth education and exchange (#erasmus, #youthexchange, #erasmusplus). These everyday hashtags bundled with general hashtags like #youthforthefuture and #justiçaclimatica integrate youth climate activism into the broader daily conversation of young people. Furthermore, compared to the prominent young climate activists, Portuguese activists

use more general-purpose hashtags, such as geo-general tags (#Portugal, #EU, #spain, #Europe, #FSCH), identity-general tags (#youth, #student), and issue-general tags (#arte, #politica, #opiniao, #podcasts, #dissemination).

Discussion

The findings indicate that digital climate publics are constituted through networks of interwoven and overlapping communities structured by hashtag use. Whereas the concept of Hashtag Publics (Rambukkana, 2015) foregrounds mobility and discursive dynamism, this study shows that these publics also exhibit navigable structural configurations. Link community analysis reveals that public formation unfolds through shared link edges that cut across issue domains, with core climate hashtags such as #FridaysForFuture and #Peoplenotprofit functioning as both thematic markers and structural bridges that connect multiple communities and bring distinct issues into a shared arena. This dynamic resonates with the relational logic of Papacharissi's (2015) affective publics, while foregrounding networked connections as the medium through which youth climate publics are continuously reconstituted through patterns of co-occurrence and linkage.

By conceptualizing the digital climate public as a form of structural emergence shaped by nested relationships among youth activists' hashtag practices, this study offers a connectivity-oriented account of public formation in digital climate activism. The analysis treats youth climate public formation as an ongoing process unfolding through the connective work hashtags perform across multiple issue communities, rather than as a pre-existing audience or event-bound assembly. This perspective extends discourse-centered accounts of hashtag publics by incorporating a structural dimension in which relational connectivity acts as a constitutive force in youth climate activism.

Centralized versus embedded discourse configurations

A small set of high-frequency hashtags gains heightened visibility while simultaneously functioning as connective nodes that link multiple parts of the semantic network (La Rocca and Boccia, 2022). Both networks are organized around climate-related communication, yet they differ substantially in the distribution of visibility, connectivity, and issue articulation. These differences point to alternative structural pathways through which climate publics are sustained in digital environments.

The X network of prominent young activists exhibits a hierarchical structure in which a limited set of climate-related tags occupies bridging positions across multiple thematic communities. Communication converges around relatively coherent issue frames, producing a climate public characterized by thematic concentration and strong internal connectivity. The Portuguese network displays a different configuration. Climate-related hashtags remain visible throughout the network, yet circulate alongside tags associated with education, feminism, party politics, environmental conflicts, and cultural activism. General-purpose hashtags facilitate movement across these thematic spaces, distributing attention across multiple issue domains and producing a more heterogeneous communicative environment.

Notably, this cross-issue integration is not confined to the Portuguese network. Even among internationally prominent activists, climate hashtags are tightly interwoven with non-climate political discourses, most visibly Palestine-solidarity hashtags such as #FreePalestine and #CeaseFireNow. This indicates that the centralized configuration on X does not consist of purely climate-focused communication, but rather binds climate concerns to globally salient political causes. The contrast between the two networks therefore lies less in whether climate discourse is integrated with other issues than in the scale of those issues: internationally oriented activists connect climate to transnational political causes, whereas Portuguese activists connect it to nationally and locally salient concerns.

These contrasting structures reflect different processes of public formation. In the international network, climate communication achieves visibility through the consolidation of shared issue frames. In the Portuguese network, climate communication acquires visibility through sustained connections with multiple public conversations. Climate discourse becomes embedded within wider political and cultural debates and remains present across a broader range of issue communities. Reach emerges through integration across domains, while coherence is maintained through recurring associations with climate-related concerns. Terren and Soler-i-Martí (2021) show that climate communication among youth activists in Barcelona intersects with feminism, housing, and social justice, whereas Portuguese activists more frequently connect it with party politics, education, and nationally salient environmental controversies. The structure of issue integration therefore reflects the political and social conditions within which climate activism develops.

The comparison indicates that digital climate publics do not follow a single communicative logic. One configuration develops through the consolidation of a coherent issue public organized around a limited set of highly central climate frames. A second configuration develops through the integration of climate discourse into multiple overlapping issue publics.

These contrasting configurations may entail different trade-offs for climate mobilization. By embedding climate concerns within non-climate discourses, the Portuguese configuration is more likely to reach publics beyond those already engaged with climate issues, although such integration may also dilute the thematic distinctiveness of climate claims. The centralized configuration on X, by contrast, sustains a more coherent and clearly bounded climate frame, yet may do so by concentrating attention among already-committed actors rather than expanding the public. Each structure generates visibility, persistence, and audience reach through different relational arrangements.

From global action to local resistance

The structural differences identified in hashtag organization suggest implications that extend beyond the internal composition of digital climate publics. They point to distinct ways in which climate communication relates to transnational processes of activism.

Research on transnational social movements has long emphasized the circulation of ideas, frames, and repertoires across geographical and political contexts (Della Porta

and Tarrow, 2005; Tarrow, 2005). Within this tradition, vernacularization has been understood as the localization of global claims through processes of cultural and political adaptation (Levitt and Merry, 2009; Merry, 2006). The present findings suggest that the relevance of global frames depends not only on their translation into local contexts, but also on the extent to which they remain structurally connected to broader networks of issue publics.

In digitally mediated activism, these connections are maintained through patterns of hashtag co-occurrence that link climate discourse to multiple domains of public life. Local adaptation does not necessarily result in separation from transnational communication. Instead, global and local frames become co-present within overlapping issue networks. Climate discourse circulates through pathways that connect domestic political debates, cultural practices, and transnational claims concerning justice and solidarity.

This pattern suggests that transnational activism operates through configurations of public connectivity rather than through linear processes of diffusion. Movement across scales depends on whether issue publics remain structurally open to external connections. Where communication converges around a limited set of central frames, transnational discourse tends to stabilize within a more bounded issue public. Where communication is distributed across multiple issue domains, transnational discourse persists through continuous articulation across heterogeneous publics.

Taken together, these configurations represent different modes through which global and local dynamics become linked in digital environments, whether by consolidating a coherent climate public or by embedding climate discourse within a wider set of public conversations. The analysis therefore suggests a shift in how transnational activism can be conceptualized in digitally networked environments. Rather than treating global and local levels as sequential stages of diffusion or adaptation, the findings highlight the importance of relational structures that sustain connections across scales. Transnational activism emerges through ongoing configurations of public articulation in which global frames, local issues, and intermediary publics remain continuously connected within overlapping communicative networks.

Conclusion

This study examined the hashtag networks of youth climate activists on social media and compared the structures of climate communication across transnational and Portuguese contexts using link community analysis. The findings demonstrate that youth climate activists use hashtags as structural mechanisms for connecting issue communities and organizing digital climate publics. Two distinct communicative configurations emerged. Prominent young activists on X rely on a centralized and hierarchical network in which a small set of core climate hashtags functions as highly visible structural hubs. Portuguese activists on Instagram distribute climate discourse across a broader range of issue domains, linking climate concerns with feminism, education, party politics, environmental conflicts, and cultural activism. These configurations illustrate different ways through which climate communication achieves visibility, reach, and continuity in digital environments.

The study contributes to scholarship on climate communication and digital activism by advancing a structural understanding of public formation. Climate publics emerge through recurring patterns of issue connectivity that link multiple thematic domains within digital networks. The significance of hashtags extends beyond categorization, visibility enhancement, or information retrieval. Through their co-occurrence, hashtags create relational infrastructures that connect issues, publics, and scales of communication. Digital climate publics therefore take shape through overlapping structures of connectivity that are continuously reproduced through communicative practice.

Methodologically, the study demonstrates the value of link community analysis for examining digital activism. Existing approaches frequently focus on individual hashtags, users, or discrete communities. Link community analysis makes visible the overlapping connections through which climate discourse simultaneously participates in multiple issue publics. This perspective offers a useful analytical framework for investigating how digital publics are structured across intersecting thematic domains and may be extended to other forms of networked activism.

Several limitations should be acknowledged. The analysis focuses on a selected group of youth climate activists and therefore does not capture the full diversity of youth climate communication. The comparison also reflects communication practices as they occur within the platforms most commonly used by each group, making it difficult to isolate platform effects from activist practices. In addition, the study prioritizes structural relationships and pays less attention to the semantic dimensions of communication. Future research could combine network analysis with semantic, framing, or sentiment approaches in order to examine how patterns of connectivity interact with processes of meaning-making. Comparative analyses across additional national contexts and activist communities would further contribute to understanding how digital climate publics develop under different political and media conditions.

Overall, the findings suggest that the formation of digital climate publics depends on the ways issues become connected across overlapping communicative spaces. Understanding climate activism therefore requires attention to the relational structures through which publics are assembled, sustained, and transformed in digital environments, alongside the content of communication itself.

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Supplemental material

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