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Connections in Climate Change. A Network Analysis of the EU-funded LIFE Sub-Programme for Climate Action in the Mediterranean Basin

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INTRODUCTION

Climate change constitutes a complex and urgent challenge that more and more requires a collaborative climate and environmental governance to reach more effective outcomes. Scientific literature has evidenced that by sharing material and non-material resources, diffusing information and co-constructing knowledge, collaborative environmental governance can enhance the probability to reach common goals in a more effective way (Bodin and Crona, 2009, Juhola et Westerhoff, 2011; Ortega Díaz and Casamadrid Gutiérrez, 2018). Besides, the multi-level nature of climate change challenges necessarily requires the coordination of different actors from different areas who operate at different scales, in order to maximize the effectiveness of climate actions (Di Gregorio et al., 2019). Nevertheless, collaborative governance also testifies criticisms in multiple circumstances. Thus, studies evidencing when and how collaborative governance is effective are in need (Bodin and Crona, 2009). In this realm, a network approach can be considered an appropriate instrument to understand better the complexity of severe environmental problems impacting on society, such as climate change (Oosterveer, 2018). As Borgatti et al. (2013) observe, differences in the structure of social networks have implications for governance and consequently for reaching its expected outcomes. In this wide context, the European Union plays an essential role in climate change adaptation and mitigation processes. In the last programming period, the attention to climate change has been strategically operationalised through an innovative sub-programme for climate action within the LIFE programme, focused on climate mitigation, adaptation, governance and information. The sub-programme cofounds environmental projects proposed by partnerships of public and private actors through grants (UE Regulation No. 1293/2013).

This study represents the first structural analysis of relations among projects and organisations implemented in the Mediterranean Basin through the LIFE sub-programme on Climate Action, by focusing on its evolving pattern (i.e. dynamic network). The network analysis proposed is related to a bipartite or two-mode network (i.e. a network where nodes are of both organisations and projects and are connected through project ties). Specifically, the following research questions have been investigated.

Q1. To what extent, have actors been connected through the LIFE sub-programme for Climate Action? Has the creation of the new sub-programme for the Climate increased the number of connections in the network?
Q2. To what extent, has the sub-programme supported intermediaries, actors who maximise the transmission and control of information and resources among projects?
Q3. What are the typologies of organization able to sustain the connectivity in the networks analyzed?

METHODS

In order to analyze the evolution of European climate actions fostered by the LIFE programme, we compared 12 bipartite networks from 2007 to 2018, composed of projects on climate change implemented in the Mediterranean Basin for every year considered and organisations involved in their implementation. The bipartite networks are constituted by two types of nodes (i.e. organisations and projects), relations are directed from the project to the organisations involved. Our analysis takes in consideration two different LIFE programming periods: LIFE+ (2007-2013) and LIFE 2014-2020 (fig.1). The latter is characterized by the introduction of an innovative sub-programme for the climate, which projects are specifically based on actions facing climate mitigation, adaptation and information challenges. Despite its recent creation, LIFE projects with effects on climate change are also implemented before the new LIFE articulation in two sub-programmes, so we selected both projects cofounded by the new sub-programme for the climate and projects characterized by the key word "climate change" implemented before the last programming period.

In order to access detailed data and information regarding LIFE Climate Action projects, the LIFE website has been consulted (https://ec.europa.eu/environment/life/project/Projects/index.cfm) where the complete database of projects is available since the first edition of the Programme. Querying by theme, key words and period, it is possible to obtain the full list of projects carrying the desiderated characteristics and thus accessing the general project information (i.e., title, project reference, duration, total budget, EU contribution, project location), and the specific ones related to the beneficiaries (i.e., coordinator, type of organisation, description, and partners excluding co-financiers). Data collected from the LIFE projects database were exported in separated MS Excel spreadsheets (i.e. node files and edge files), two for every year analyzed (totally 24 spreadsheets) taking in consideration projects that are operative for every single year. Data in the spreadsheets have been used as input data for the SNA (Social Network Analysis), implemented via GEPHY® software. Additional statistical elaborations have been performed via R statistical software (tnet package) focusing the attention on specific network statistics computed for the case of bi-partite and dynamic networks. More specifically are used the following statistics:

-Q1: To understand the level of connectivity of in the networks, we calculate the density and clustering coefficient. Density represents the level of cohesiveness of the network. The graph density represents the proportion of observed connections between nodes to the maximum number of possible connections. It also reflects the degree of interconnectivity between nodes. In the case of a bipartite network, the density is computed as "the number of edges divided the number of pairs of nodes" (Borgatti and Everett, 1997: 254). Clustering coefficient relates to the tendency of nodes to aggregate together by forming densely connected groups within the network. Higher levels of collaboration characterize these groups, but at the same time, they could tend to avoid relations with other groups. In the case of bipartite networks, we calculate the global clustering coefficient as the proportion of the closed number of 4 paths (i.e. three nodes of the first set, four nodes of the second set connected by six edges) over the total number of 4 paths in the network (Ophsal, 2013).

-Q2 & Q3: We identify central nodes in the networks thanks to betweenness and degree centrality using tnet package on R software. Betweenness centrality measures "the frequency with which a point falls between pairs of other points on the shortest or geodesic paths connecting them" (Freeman, 1978: 221). The betweenness centrality evidences the node's capacity to act as a gatekeeper by facilitating the stream of what passes through the web of connections. Degree centrality represents the number of relations that a specific node has, this measure focuses on the local structure around the node by evidencing its level of influence on the surroundings, but it does not consider the entire structure of the network (Ophsal et al., 2011). After the identification of central nodes, we calculate the ratio of the numerosity of central nodes to the total number of organizations operating in the network for all the twelve years analyzed in order to make evidence of intermediaries numerosity's trend (Q2). Then we select the first five nodes having the higher values of betweenness and degree centrality to identify what types of organizations mostly promote interconnections through actors operating in different LIFE projects on climate action (Q3).

CONCLUSIONS

•Organisations cofounded by the LIFE Programme on climate action are mainly from the Mediterranean Basin; this reflects the higher relevance of climate change effects in these contexts. Mediterranean area is the European region most affected by the effects of climate change (Ciscar et al., 2018). In most of the Meditteranean countries we have analysed, the EU-funded LIFE Programme represents the primary possibility to implement actions for climate change tackled from an environmental perspective.

•Networks created by relations between projects and organisations evidence an evolving pattern in their structure. Specifically, structural features evidence an enhancing number of organisations involved complemented by an increasing tendency to collaborate for reaching climate policy objectives. From 2014 to present days, this structural feature has been further sustained by the creation of an ad hoc new LIFE sub-Programme for the Climate Action.

• Although the number of projects and organisations in the second programming period analysed is higher than in the first one, the density values are reduced and quite stable for all years considered. This attitude reflects the tendency of organisations to remain separated and to be involved in only one project per year. The result evidence the need to increase connections through organisations. In this way, the flow of resources can also reach more nodes which are in the peripheral positions of the network. The reduced density complements with the analysis of the clustering coefficient values, which are not stable during the years, and are always very low.

• Despite low values of density and clustering coefficients, there is an increasing trend of actors having a non-null value of betweenness centrality and involved in more than one project at the same time. This result evidences the need to sustain further the exchange of information, resources and results achieved through all organisations in the network. In this way, organisations could implement actions more effectively and with synergic approaches.

• Organisations characterised by the highest values of betweenness and degree centrality are all public bodies, mostly universities and research institutes. The result evidences the need to promote further their involvement in LIFE projects to maximise the flow of material and non-material resources. At the same time, it also reflects the need to increase the involvement of private bodies which could enhance the capacity of the programme to spread its effects.

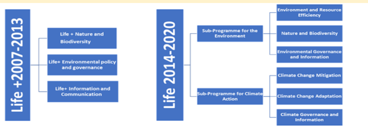

Figure1: LIFE Programme structure in 2007-2013, 2014-2020

RESULTS

Q1- In the 2007-2013 programming period, the LIFE Programme cofounded 113 projects on climate actions, involving 427 organisations that create 498 relations. In the second programming period, and specifically from 2014 to 2018, LIFE Programme cofounds 89 projects and 470 organisations with the creation of 557 relations. The analysis takes into consideration projects implemented in the Mediterranean Basin, in particular in Spain, Italy, Portugal, Greece, Malta, Cyprus and Slovenia. The three graphs in fig. 2 show the evolution of the network structure from 2007 to 2018- Specifically, for the graphical representations, we have selected networks of the first (2007), central (2013) and last (2018) year of the time series. Graphs show the tendency to aggregate during the years, and the increasing amount of projects and organisations involved in Climate Change actions also attested in figure 3a.

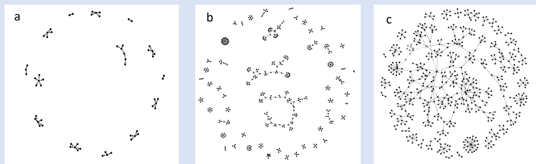

Figure2: Network structure of projects implemented in 2007 (a), 2013 (b), 2018 (c). Source: our elaboration from GEPHY ®

Density values computed for every graph shows low values for all the years analysed, values range from 0.1 to 0.2 (fig.3b), in a 0-1 interval, where 0 represent the absence of linkages between nodes, and one the connection between all nodes in the network. Figure 3c shows the evolution of the global clustering coefficient during the years; it is possible to note that only after five years, the value computed is more than 0. The trend of the clustering coefficient is not regular; this is caused by the non-stop starting and ending of partnerships due by the duration of the projects.

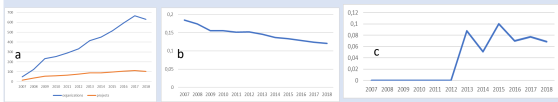

Figure 3: a) trend of the numerosity of projects and organizations cofounded by the LIFE programme for the Climate; b) networks densities from 2007 to 2018 ; c) clustering coeffient calculated from 2007 to 2018. Sources: our elaboration from the LIFE database based on R software.

Q2. The identification of central nodes allows us to understand the distribution of power in the network structure: betweenness centrality represents the role of brokerage exerted by actors, degree centrality testifies the local influence for every node. If a project partnership has almost one central actor, there are more opportunities to have access to more information and resources and to spread as broader as possible the outputs of the project. This study wants to test if there is an increasing number of nodes having a value of the betweenness centrality higher than 0 and a degree centrality higher than two (nodes are involved in more than two projects in the same year). The ratio between selected nodes and the total number of organisations operating every year is reported in figure 4. It shows an increasing trend for both the centrality values analysed affirming the capacity of the LIFE Programme to promote the involvement of central actors in different projects.

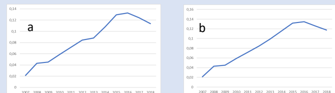

Figure 4: trend of ratio between organization with a value of betweenness centrality higher than 0 (a) and degree centrality value higher than 2 (b) to the total number of operative organizations from 2007 to 2018. Sources: our elaboration from R software

Q3-The identification of nodes having the highest values of betweenness and degree centrality make evidence that only public bodies can act as a bridge making connections with other nodes in the networks (fig.5). In particular, universities and research institutes are the most relevant organisations able to assure the flow of information and resources through the network of different organisations involved in different projects.

Figure 5: Typologies of organisations having the most highest value of betweenness and degree centrality. Source: our elaboration based on R software and LIFE database.

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