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Who Is Connected with Whom? A Social Network Analysis of Institutional Interactions in the European CCA and DRR Landscape

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Abstract: Communication and collaboration are critical for designing and implementing responses to climate change impacts and related disasters. This acknowledgement has increased interest in understanding social and institutional networks for climate change adaptation (CCA) and disaster risk reduction (DRR). In this study, we used Social Network Analysis (SNA) to explore institutional interactions within and across the communities of the aforementioned domains in Europe. Firstly, we investigated the type and intensity of interactions. We calculated SNA metrics to assess the roles of different actors and applied cluster analysis to identify actors with similar patterns of connections. SNA showed that communication is often more intensive within the two communities, while collaboration is frequent around topics related to both CCA and DRR. Cluster analysis revealed that actors tied with DRR were more closely connected, while actors tied with CCA and those with mixed connections showed no obvious clustering affinity. The European Climate Adaptation Platform, Climate-ADAPT, had the highest value for various SNA metrics, reflecting its popularity in the network and its potential for enhancing interactions among its actors. Finally, SNA was complemented by qualitative interviews, which emphasised the importance of connecting CCA and DRR in organisational mission and vision statements.

Keywords: social network analysis; institutional actors; climate change adaptation; disaster risk reduction; Europe

1. Introduction

After almost two decades of ongoing discussions and negotiations, adaptation has become a priority in national and international political agendas, and is now considered not only an important but also a necessary element of any autonomous or planned response to climate change [1–3]. Similarly, past years witnessed growing efforts to improve reduction of disaster risks, by looking at their causal factors and possible future risks, paving the way for an integrated framework for disaster risk reduction [4].

Climate change adaptation (CCA) and disaster risk reduction (DRR) both aim to address issues relevant for multiple sectors and governance levels, such as the changing type, severity, and frequency of climate change impacts, and weather- and climate-related risks. Such challenges require flexible and

transformative responses, and a good understanding of the social and institutional structures is critical for catalysing them.

At the community level, communication and collaboration have proven to be crucial in preparing for, responding to, or recovering from climate-related hazards [5–7]. People who are well connected to their networks have better access to knowledge, resources, and skills, and can provide or receive prompt support (e.g., physical, economic, psychological). The importance of social capital (which is defined as "[. . .] the institutions that help us maintain and develop human capital in partnership with others; e.g., families, communities, businesses, trade unions, schools, and voluntary organisations" (https://www.forumforthefuture.org/project/five-capitals/overview)) in such circumstances was lately demonstrated during the post-Hurricane Sandy recovery phase [8,9]. People living in neighbourhoods with more social resources and connections were, and perceived themselves as, more resilient, even in cases where available financial resources were low [10].

At the institutional level, recent policy developments, such as the EU Adaptation Strategy [11], the Paris Agreement [12], the Agenda 2030 for Sustainable Development [13], and the Sendai Framework for Disaster Risk Reduction [14,15] have underlined not only the importance of adaptation and risk reduction, but also the co-benefits that may arise from aligned policies and action [16–19]. Legal and institutional frameworks undoubtedly play a critical role in creating an enabling or inhibiting environment for developing synergies between relevant policies and cross-references in policy documents represent the first step of integration (see [20]). The implementation of such processes on the ground, however, depends largely on the case-by-case effectiveness of multi-actor coordination. This involves, among others, communication and collaboration among a wide range of institutions [21,22].

The acknowledgement of the importance of networks, and the social and institutional interactions that are embedded in them, has already been reflected in the research, with an increase in the number of studies exploring their role for CCA and DRR [3,5,9,23–30]. Social Network Analysis (SNA) has been one of the most widely used methods in these studies. A recent literature review showed that SNA has been used primarily for understanding (i) the structure and (ii) the functions of a network; (iii) the strength of the relationships between people and/or organisations; (iv) the way that networks evolve; and (v) the flow of information between different actors in a network (for detailed information on the literature review see [31]).

This study contributes to the literature by furthering the understanding of interactions within the boundaries of the CCA and DRR communities and investigating interactions between them as, to the best of our knowledge, such studies are still rare [32]. We examined the interactions between 35 selected actors in Europe, whose work or mission is associated with CCA and /or DRR. SNA metrics were calculated to quantitatively assess actors' interactions and their roles in the network. This allowed us to identify the actors that play a key role in the European CCA/DRR landscape and investigate the structure of the network. Targeted in-depth interviews with selected stakeholders enabled us to better understand the SNA results, and supported the development of recommendations about possible ways to improve coherence in the merged CCA/DRR European network, making our contribution highly politically relevant.

2. Materials and Methods

2.1. Social Network Analysis

Social Network Analysis (SNA) is a quantitative method that has the ability to express statistically and graphically patterns of interactions in complex systems such as networks [28] (Qualitative Social Network Analysis (or social network mapping) exists also. For further information see [33]). Networks are composed of ties (i.e., edges) that connect actors (i.e., vertices). By focusing on the characteristics of the ties rather than on those of the actors [34], it is possible to compute SNA metrics that

indicate the roles that different actors have in a network, to identify which actors are better connected and through which type of interaction [35], and to visualise the emerged networks via sociograms.

Qualitative information collected via interviews with key actors, as done in this study (see Section 2.2), may complement the findings of an SNA by providing contextual information [36] that helps to better understand why certain interaction patterns emerge. Such double-step approaches are clearly desirable for results' triangulation. Nevertheless, they are rather uncommon due to the additional time and effort required [37].

2.2. Data Collection

An inventory of actors active in the fields of CCA and/or DRR was prepared prior to the application of the SNA. The inventory included information on the (1) vision/mission statement, (2) core competencies, (3) field of work (CCA, DRR, other), (4) sector, (5) geographical scope of work, (6) target group, (7) physical headquarters, (8) URL address, (9) contact person, and (10) other information. As of April 2016, 137 stakeholders (stakeholder and boundary organisations, knowledge platforms, policy and research initiatives, existing networks/partnerships, and end user needs (SPINE)) had been identified through extensive desktop research, expert judgement and snowball sampling, providing a good overview of actors from the CCA and DRR communities visible on the European level. The two latter techniques were used to complement the initial list of key actors obtained through desktop research. During several CCA and DRR events, a set of relevant actors was asked to indicate other actors with whom they have a professional relationship with regard to their work on CCA and/or DRR issues. The procedure was repeated with each group of the identified stakeholders until the research team was sufficiently confident that all major CCA and DRR stakeholders active in the European arena were covered. Methods such as expert judgment and snowball sampling may introduce a certain degree of bias due to their inherent subjectivity. In this study, however, saturation was reached; a point where no new actors were suggested to be contacted. This indicated that all key actors had been identified and considered in the study.

Subject to our objective, 35 actors were selected from the above-mentioned list using expert elicitation method, to identify a compact but representative sample of the European CCA/DRR landscape. All actors included in the final set were invited to participate in the SNA survey (Appendix A).

SNA was conducted using information about the intensity and the type of interactions between the selected actors (the survey questionnaire can be found in Appendix B). Data were collected through an online survey that was developed on the SurveyMonkey platform and administered by email to one contact person for each actor considered in the network. Potential respondents were selected based on their suitability for answering the specific questions. In some cases, invited respondents suggested alternative people to participate in the survey on behalf of their organisation. Whatever the case, participation in the survey was by invitation only and responses were collected from only one representative of each of the selected actors. Invited participants were encouraged to consult with their colleagues, especially in cases where the organisations they represented had more than one unit working on CCA- and DRR-related issues. Data collection took place in July and August 2016, and 32 responses were received out of the 35 invited actors. For confidentiality reasons, this paper does not contain any information on the actual respondents except for the names of the organisations. The electronic files of the responses can be made available upon request and only after asking for the consent of the organisations involved in this exercise.

After the SNA exercise, in-depth interviews were conducted with a subset of the top-performing actors according to SNA metrics (see Table 2 in the 'Results and Discussion' section and Appendix C). These actors were informed about the purpose of the follow-up interviews and received a confidentiality statement along with a compilation of the SNA results prior to the interviews.

The interviews aimed to explore whether the SNA results were in line with the expectations of the respondents or not, and also collected additional information that could support a better explanation of the SNA results. Follow-up questions explored additional aspects, such as the factors that positively

influence openness towards the other community and the perception of their own and the counterpart community. Given the above-mentioned aims, interviews followed a semi-structured approach, using a predefined set of closed and open-ended questions (See Appendix D for the interview guidelines). This approach allowed us to maintain the focus of the interview, providing at the same time sufficient space for additional questions, comments and reflections.

2.3. Data Analysis

NodeXL Pro software package (Version 1.0.1.389) (http://www.smrfoundation.org/nodexl/) was used to calculate SNA metrics that show the basic properties of the network under study (Table 1) and generate sociograms to visualise the network's communication and collaboration interactions between different actors.

In the SNA, we considered all interactions except for those indicating awareness of actors but lack of interaction with them (level 1 – "I am aware that this actor exists, but to my knowledge, we do not have any contact with them", see Appendix A). Directed sociograms were generated using the Haren–Korel Fast Multiscale layout algorithm, "a force-directed layout algorithm using optimisation in order to make the algorithm computationally efficient" ([38], p. 274]).

Besides the SNA, we also conducted a cluster analysis to detect groups of actors with similar patterns of connections, by minimising the diversity within a cluster and maximising the diversity between them. The NodeXL group analysis tool provides the Clauset–Newman–Moore algorithm and the Girvan–Newman algorithm. The Clauset–Newman–Moore algorithm is an agglomerative algorithm; it starts with a community partition, where each single vertex represents a community and then at each iteration, a pair of communities is merged into a single one, improving the measure of cluster quality. This process continues until any further aggregations would decrease the overall quality [39]. The Girvan–Newman algorithm is a divisive method based on the edge removal; it progressively removes edges from the network, focusing on edges between loosely connected communities (i.e., those with high "betweenness" value). By removing these edges, the communities are separated from one another and presented as clusters [40].

Table 1. Definitions of the SNA metrics calculated in this study.

SNA Metric	Definition
Density	It is calculated as the proportion of the total number of actual interactions among the actors of a network, out of the total number of potential interactions. The higher the value of the density, the higher the connectivity of the network.
Degree centrality	It presents the total number of interactions of an actor regardless of their direction. It is a good indicator of certain actors' ability to communicate directly with other actors in the network, as well as of their importance for transferring information. In the case of directed networks, degree centrality is divided into in-degree and out-degree.
In-degree centrality	It presents the total number of incoming interactions to an actor. Actors' in-degree centrality increases with the number of actors indicating that they seek information or collaboration with the former and does not consider an actor's own assessment. It may be used for identifying actors that are popular in a network.
Out-degree centrality	It presents the interactions outgoing from an actor. It may be used for identifying actors that tend to interact a lot with other actors in the network as a result of the initiative of the former.
Betweenness centrality	It is calculated on the basis of the times that a vertex acts as a bridge in a network (i.e., lying on the shortest path between two actors). An actor with a high betweenness centrality value has the power to connect disconnected groups, to broker opinions and to influence the flow of information. It may be used as an index of the control that an actor has over the connections in a network.

Table 1. *Cont.*

SNA Metric	Definition
Eigenvector centrality	It is calculated on the basis of an actor's own degree along with the degrees of the actors to which the former connects. It assigns relative scores to all vertices in a network based on the principle that connections to a high-scoring vertex contribute more to the score of the vertex in question than an equal number of connections to low-scoring vertices. It is another measure of an actor's importance in a network and may be used for identifying the popularity of an actor's partners.
Clustering coefficient	It quantifies the proximity of a vertex and its neighbours. It is calculated on the basis of the degree to which vertices tend to cluster together. Vertices with high degree values have lower clustering coefficients because they connect to many vertices who are not connected among them. On the contrary, vertices with high clustering coefficients tend to have fewer connections, since small groups have larger potential to connect every member to one another.

Source: [28,29,41–43].

Finally, a content analysis of the interview notes, including coding and qualitative assessment of the collected information, was carried out to identify concepts/themes contained in the data. Excel filters helped to analyse the data vertically—looking for coherence and a narrative thread within each interview, and horizontally—trying to recognise general patterns and differences.

3. Results and Discussion

3.1. Social Network Analysis

Social network analysis considered 35 vertices (i.e., actors) and a total of 470 edges (i.e., interactions). For the three actors that did not participate in the survey, we considered the relationships that other actors in the network specified to have with them. Among the survey participants, 16 actors had CCA as their primary or secondary core competency, 11 came from the field of DRR (including risk assessment), while the rest of the actors came from the insurance, climate research, and sustainable development sectors, with direct links to the field of CCA and/or DRR. All of the actors represented leading organisations that operate in, or have an impact on, the European CCA and DRR landscape, and have different but overlapping mandates, roles, responsibilities, and interests (information on actors' characteristics can be found in Appendix E).

Table 2 provides an overview of the top performing actors based on the calculated SNA metrics. Although a few "outliers" could be observed scoring high in only one category, altogether, the highest places in the ranking with regard to different SNA metrics were very often occupied by the same actors. These included EU institutions in charge of EU policies (e.g., DG CLIMA, DG RTD), EU organisations involved in knowledge production and dissemination (e.g., JRC, EEA), international bodies (e.g., IPCC, UNEP, UNISDR-Europe), research institutes with international reputation (e.g., IIASA), networks (e.g., EpaNet, STAG), and platforms (e.g., Climate-ADAPT, PreventionWeb). The calculated scores reflect the popularity of these actors and their high potential for improving information flow and links, especially with actors that are not well connected to the rest of the network. High values were calculated also for actors coming from the private sector such as insurance companies (e.g., MunichRe, Swiss Re) for all but one metric (betweenness centrality). This result reflects the transition that is seen in many countries where the influence of the private sector overall both on the development and implementation of CCA and DRR policies has been growing constantly and with prospects to increase further in the future (https://climate-adapt.eea.europa.eu/eu-adaptation-policy/strategy). Still, the lower betweenness centrality of these actors may signal that they are not yet ready to play a significant role in connecting other actors in the merged network (or are not yet recognised as such).

An interesting observation is that many actors had high eigenvector centrality values. This likely resulted from the fact that they are connected to the 'well-connected' actors, such as Climate-ADAPT and DG CLIMA, increasing their overall score for this metric. Furthermore, this finding emphasises the role of the best-connected actors in reaching out to and bridging other actors in the network.

Table 2. Ranking of top 10 actors with regard to different Social Network Analysis (SNA) metric values. Actors marked in bold participated in an additional in-depth interview. A complete list of all actors and SNA metric values can be found in the Appendix C.

Ranking Order	Degree Centrality (Sum of In-Degree and Out-Degree)	In-Degree Centrality	Betweenness Centrality	Eigenvector Centrality
1	**Climate-ADAPT** (50)	**DG CLIMA** (27)	**Climate-ADAPT** (101.815)	**Climate-ADAPT, DG RTD** (0.043)
2	**DG RTD** (47)	**EEA** (25)	**DG RTD** (52.863)	**DG CLIMA** (0.041)
3	**DG CLIMA, EEA** (46)	**IPCC** (24)	**DG CLIMA** (45.396)	UNEP (0.039)
4	**UNISDR Europe** (43)	**JRC** (23)	**EEA** (34.670)	**EEA, UNISDR Europe** (0.038)
5	**IPCC** (39)	**Climate-ADAPT, PreventionWeb**, UNEP (22)	**JRC** (27.886)	IIASA, **IPCC, PreventionWeb** (0.037)
6	UNEP (38)	**UNISDR Europe**, UNDP (20)	UNEP (24.510)	IFRC, STAG, UNISDR (0.035)
7	**PreventionWeb** (35)	**DG RTD**, IFRC CC (18)	**IPCC** (22.166)	JRC (0.034)
8	IIASA (34)	DG ECHO, MunichRe (17)	**UNISDR Europe** (21.106)	DG ECHO, SwissRe, UNDP (0.033)
9	DG ECHO, **JRC** (33)	ICLEI Europe (16)	EPANet (21.019)	JPI Climate (0.032)
10	JPI Climate, STAG, SwissRe, UNISDR (32)	PROVIA, SwissRe (15)	IIASA (20.709)	MunichRe (0.031)

The European Climate Adaptation Platform (Climate-ADAPT) emerged as the actor with the highest value for most SNA metrics: i.e., degree (Figure 1a), betweenness (Figure 1b), and eigenvector centrality (Figure 1c). These findings reflect the popularity of Climate-ADAPT in the network, its important role in communicating with the rest of the actors (i.e., degree and eigenvector centrality), as well as its outstanding ability to set up communication bridges with those actors that do not have reciprocal interactions (i.e., betweenness centrality). With regard to the in-degree centrality, which indicates the number of ties others specified to have with a specific actor, Climate-ADAPT was positioned only after DG CLIMA, EEA, IPCC, and JRC. Further to Climate-ADAPT, similar disparity between in- and out-degree centrality values was observed also for DG RTD (22 and 18 for in-degree, against 28 and 29 for out-degree, for Climate-ADAPT and DG RTD, respectively). This higher number of the outgoing compared to the incoming interactions, may imply that Climate-ADAPT and DG RTD seek, in an active way, to reach out to other actors in the network, which is seen as a way to engage with their target audiences. Such an attitude and the position in the network, as indicated by the high betweenness and out-degree centrality, point out these two actors as good candidates for linking other actors in the merged CCA and DRR network.

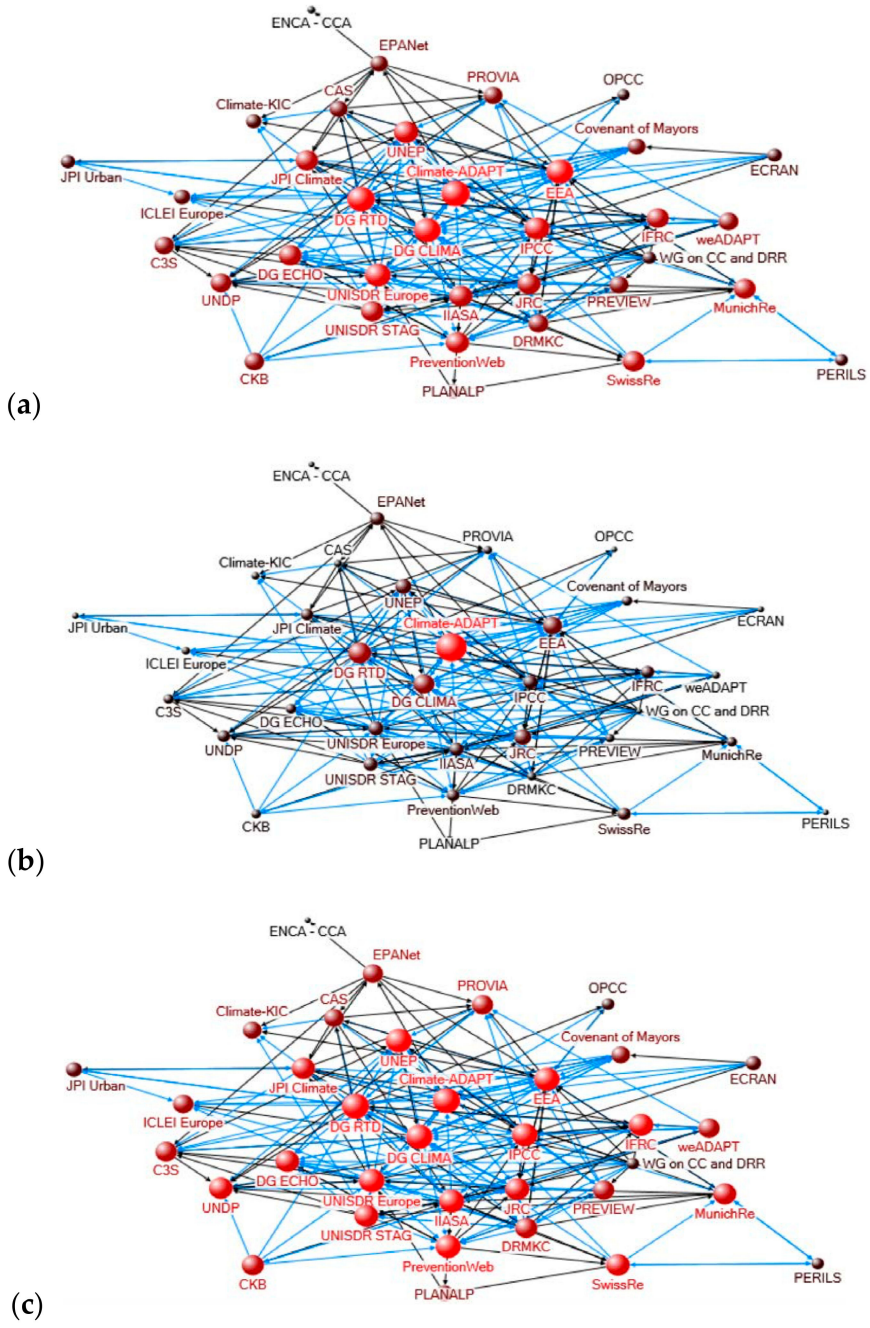

Figure 1. SNA based on intensive communication and collaboration interactions, presenting degree centrality (**a**), betweenness centrality (**b**), and eigenvector centrality (**c**). Node size and colour are determined by the depicted SNA metric. Strong communication is represented with black and strong collaboration with blue edges.

The important and influential role of Climate-ADAPT that was revealed from the SNA in this study agrees with findings from other recent studies that have highlighted the potential of web platforms to support an improved communication and knowledge exchange between the CCA and DRR policy domains [2,19,44]. Climate-ADAPT was launched in 2012 by the European Commission and the European Environment Agency (EEA) in an attempt to facilitate dissemination and use of the produced 'adaptation knowledge' in Europe, and through this to support evidence-based policy- and decision-making, and improve coordination among actors operating in different sectors and at different governance levels [45]. Although the primary focus of Climate-ADAPT is indeed the field of CCA,

it is worth noting that the amount of DRR information that it provides has been constantly increasing. For example, as at 22 January 2020, the Climate-ADAPT database included 553 items relevant to the DRR sector, while a page providing information about the policies of the DRR sector is available on the main site of the platform. Moreover, the recent evaluation of the EU Adaptation Strategy [46] also included the evaluation of the Climate-ADAPT platform and confirmed its increasing value for several types of users (e.g., policy makers, city planners, experts). The outcome of the SNA in this study seems to be confirming this conclusion.

Similarly, the Directorate-General for Research and Innovation (DG RTD) has a mission to develop and implement research and innovation policies in Europe. Tackling some of the main current and future societal challenges has been identified as one of its key aims. Clearly climate change, climate change impacts, and weather- and climate-related disasters are among the most important and direct challenges that societies are facing. Therefore, this may explain the fact that DG RTD has an active role in reaching out to both of CCA and DRR communities.

Further to the calculation of the SNA metrics, a graphical representation of the SNA results was prepared in the form of sociograms. As actors in the investigated network were densely connected (network density: 0.39), the following sociograms illustrate only the strong interactions, while the more sporadic ones were excluded in order to improve visualisation. More specifically, Figure 1a–c depict the network of actors that have established (either by indicating or receiving) frequent communication and frequent or institutionalised collaboration interactions with other actors in the network. The different colours of the ties reflect the type of the interactions, while node size reflects the values of the SNA metrics; degree, betweenness, and eigenvector centrality, calculated for each actor.

Finally, taking a closer look at the type of interactions that actors indicated (Table 3), we saw that the type of interaction was specified by participants in almost all cases (ca. 90% for communication and 95% for collaboration interactions, respectively). Collaboration was most often mentioned with reference to issues that relate to both CCA and DRR, while communication was more frequently mentioned for issues that refer to the CCA domain. This result might suggest that issues related to either CCA or DRR can be tackled effectively through communication channels alone, while addressing issues that are relevant to both domains requires closer interactions among interested organisations.

Table 3. Number of interactions per type of interaction (intensity and type).

Type of Interaction	CCA	DRR	CCA & DRR	Unspecified	Total
Communication	93	60	78	27	258
Collaboration	71	45	86	10	212

As already discussed in the literature, insufficient or lack of cooperation across responsible institutions is a key constraint when facing a crisis or emergency in different contexts [47]. For this reason, the presence of collaborative institutional interactions is usually considered a positive element in a network. However, there are conditions where collaboration may not ensure successful responses [48]. A holistic assessment of collaborative interactions is expected to be more insightful in showing their usefulness and impact on the overall network and the processes taking place in it (e.g., learning) [47–49]. This assessment should not only consider numerical information (i.e., total number of indicated interactions), but also other dimensions, such as the quality and efficiency of collaboration.

Finally, cross-organisational communication and collaboration are indeed crucial for addressing issues relevant to both CCA and DRR policy domains. Although this study provides evidence that suggests that such collaborative interactions have been already taking place, a full integration of CCA and DRR is still to be achieved in the future.

3.2. Cluster Analysis

Cluster analysis, using the Clauset–Newman–Moore algorithm, resulted in two large and one small cluster (Figure 2a). This visual representation of the cluster analysis shows that connections related to DRR predominantly appear in one of the two large clusters. Then again, connections related to CCA appear mainly in the other large cluster and in the small cluster, but they are also present in the "DRR dominant" large cluster. Cluster analysis was repeated using the Girvan–Newman algorithm based on edge removal. This clustering exercise found one large and 21 small (one-member) clusters (Figure 2b). The large cluster contains mainly DRR actors, while no obvious clustering pattern was found between the actors related to CCA or those with mixed connections.

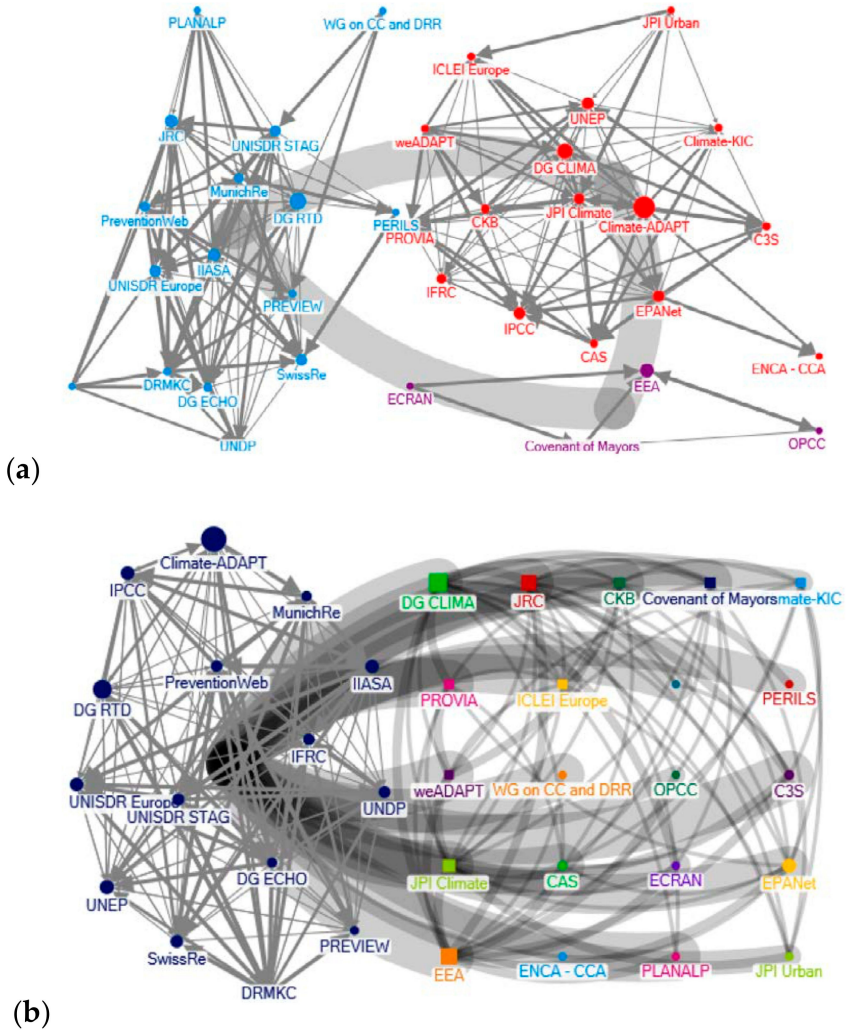

Figure 2. Cluster analysis using the Clauser–Newman–Moore algorithm (**a**) and Girvan–Newman algorithm (**b**). Node size is determined by betweenness centrality values and the vertex colour is determined by the affiliation to one of the three clusters. The intergroup (inter-cluster) edges are combined for a better visual representation of the clusters.

Overall, the cluster analysis with either of the two different methods shows that actors tied with DRR are more closely connected, which may suggest the existence of more effective interactions among them. Addressing matters related to DRR is characterised by a certain degree of urgency, which requires fast responses and, therefore, closer and more structured interactions. On the other hand, the fact that actors tied with CCA and those with mixed connections showed no obvious clustering

affinity may reflect the fact these types of connections involve a more widespread network of actors, as they deal with many different topics, sectors, and policy levels.

3.3. Key Results from the In-Depth Interviews

In-depth interviews were conducted with representatives from Climate-ADAPT, DG CLIMA, DG RTD, EEA, Intergovernmental Panel on Climate Change (IPCC), Joint Research Centre (JRC), PreventionWeb, and UNISDR Europe (one interviewee represented two organisations). Organisations were selected based on the importance of their role in the investigated network as this was reflected in the calculated SNA metrics (see Table 2).

Interviewees' expectations regarding the roles and the interactions of the considered actors were in agreement with the SNA results, but for a few cases. For the case of Climate-ADAPT, the popularity of the platform (i.e., high degree centrality value) was explained by the fact that it provides a wide range of information, reports, tools, and case studies, making it an important source of information for stakeholders operating at different governance levels and in different sectors. Its important role as a bridge between CCA and DRR communities was related to its mandate and the actions taken by its governing bodies to support and contribute to the coherence between the two domains. As a result, relevant initiatives taken by the platform itself, e.g., inclusion of DRR material in the database of the platform, as well as other relevant actions taken by its governing bodies towards the achievement of this objective (e.g., the EEA published in 2017 a report on CCA and DRR in Europe [18]) were mentioned to justify the role attributed to the platform. Also, some interviewees stressed that Climate-ADAPT actively reaches out to interested stakeholders by means of diverse activities and channels (e.g., workshops, conferences, newsletter with over 5000 recipients), which agrees with the high out-degree centrality score that was calculated for this actor.

When asked about the organisational characteristics and other external factors that can positively influence an actor's openness towards the other community, interviewees most frequently named the role of the organisational strategy that creates a sense for collaboration and previous experience with international and interdisciplinary issues. Commitment and determination to conduct joint projects, as well as strong leadership and support from the top management, were ranked second with regard to the frequency of responses. Tangible resources such as financial and human resources and IT were also mentioned as important enablers for creating open interdisciplinary work environment. Nevertheless, such factors were referred to less frequently, underlining the role of "soft" features (see Table 4 for the full list of factors).

Table 4. Factors enhancing organisational openness and interdisciplinary work according to interviewed stakeholders (numbers in the parentheses indicate the number of respondents who mentioned each factor during their interviews).

Factors Enhancing Organisational Openness and Interdisciplinary Work	No of Responses
Organisational strategy, including mission and vision statements	4
International and interdisciplinary work	4
Mix of motivation, commitment, and determination	3
Strong leadership, support from the top	3
Organisational resources: finance	2
Science-based approach (credible information)	2
Transparency/Trust	2
Organisational resources: Staff and IT	1
Communication skills	1
Political mandate (extension of the network)	1
Common legislation or at least cross-references	1

With regard to the results of the cluster analysis, respondents confirmed unanimously the existence of two clusters related to CCA and DRR, respectively. Interpretation of the respondents' results could

be traced back, to some extent, to the perception question, in particular with regard to self-perception and perception of the other community. Respondents working in the field of CCA perceive DRR as a single solid cluster with a long tradition, having its roots in humanitarian aid, and describe CCA as a relatively younger and fast-developing domain, that deals with many topics relevant for several sectors and disciplines. On the other hand, interviewees with a DRR background describe CCA as a part of the DRR policy domain, since climate change is just one out of many risks that DRR deals with. One interviewee referred to mitigation and adaptation as "[. . .] a form of risk reduction", since it aims to reduce the occurrence of new and limits the amplification of existing climate-related risks. Furthermore, actors with expertise in DRR perceive their community as an established field with a great deal of practical knowledge in the area of emergency response, spanning over social, health, and earth sciences. However, the production of science-based knowledge is considered a relatively new task in the DRR community, triggered by increased interest in planning and prevention.

In contrast to CCA respondents, the interviewed DRR experts were surprised by the difference in the density of the two clusters. One interviewee pointed out that in reality the DRR community is more widespread as it includes many small, less-institutionalised knowledge producers, further to the organisations that are embedded in the field in strict terms. The same interviewee pointed to the fact that by selecting the most prominent DRR actors from the European/international level, the SNA managed to capture only "a piece of the DRR universe". Another interviewee coming from the DRR community hypothesised that the spread of the CCA community might be attributable to its need to draw on a wider knowledge spectrum, than the one used by the DRR community, which depends heavily on future projections and requires a lot of simulation work and modelling.

Furthermore, all respondents pointed to a lack of alignment between CCA and DRR. This originates from the different backgrounds (humanitarian aid: bottom-up approach vs. science and policy: top-down approach), governance structures (different ministries in charge), foci (e.g., many risks vs. risk of climate change, risks vs. uncertainties), used terminology, responsibilities, and time frames (present and near future vs. long-term predictions) that characterised the two fields, and results in limited communication and collaboration between them. More specifically, it was mentioned that communication takes place mainly in silos, and, in contrast to what the SNA revealed, collaboration between CCA and DRR is still weak, but for a few best-practice examples that were described as exceptions that prove the rule.

As noted by one of the interviewees, people tend to talk to like-minded people from their network (i.e., homophily), but sometimes work with people from very different backgrounds and priorities because they are obliged to do so, or because they perceive gains that outweigh the transaction costs (e.g., an extra effort related to different terminologies, etc.). Another interviewee linked the homogeneous communication patterns with the question of self-identification "You talk to CCA groups if you self-identify as CCA, and vice versa". The same interviewee stressed that in their organisation they distinguish between two groups of stakeholders: (1) those who identify with DRR and (2) those who do not, but are an integral part of the DRR community because their work is crucial for prevention and preparedness (e.g., climate and weather services). Also, in some cases, we observed a self-perception bias. IPCC, for example, did not identify itself as an actor that could facilitate dialogue between the two communities, while other actors in the network referred to it as an actor with high communication potential.

Finally, it was mentioned that institutions that aim to fill in these gaps and bring the two communities closer need not only to have strong motivation and commitment, but also to show patience and perseverance, as the alignment of interests is a rather time consuming process with a considerable risk of failure.

3.4. SNA Limitations

Certain challenges emerged when designing and applying SNA in this study, however providing solutions to them is not within the scope of this paper. This is because the effectiveness of any action

to overcome these challenges will depend very much on the context and specific design of any other study. Nevertheless, communicating the key constraints faced here may help other researchers when designing analogous SNA exercises in the future.

(a) **Boundaries of a network:** Deciding on the composition and size of a network is a common challenge in SNA. An *ex ante* attempt to create a balanced network in this study proved to be rather difficult, as certain actors could fall in more than one category of the classifications that we considered. Also, looking at the CCA and DRR communities considered in this study, some of the interviewed experts commented that both of them (especially the DRR community) are more diverse in real life. Involving a larger number of actors may have ensured a wider and perhaps more accurate representation in the network. Nevertheless, such an approach could have other implications, such as a negative impact on the overall response rate of the survey (see point c below).

(b) **Survey administration:** Identification of suitable survey participants, frequent staff turnover, and unavailability of some invited participants to provide responses on behalf of their organisations were the main reasons that delayed the prompt administration of the survey.

(c) **Repetitive pattern of the SNA questionnaire:** Questions in the SNA survey had a rather repetitive pattern. Especially in cases of large networks, this characteristic causes fatigue, which is usually responsible for incomplete or lack of responses. In our study, participants were asked to specify both the type and intensity of relationships they had with other actors, causing an additional workload while responding to the survey.

(d) **No responses:** Interactions of the actors that did not participate in the survey were treated as 'no responses', allowing us to take into consideration the interactions indicated by the survey respondents also for the non-respondents. Although it was not the case in this study, this approach may have implications on the calculated SNA metrics (see also [29,33]), especially if the non-respondent actors receive a large number of interactions.

(e) **Subjectivity bias:** Survey participants were encouraged to consult their colleagues when answering the SNA survey, especially when more than one division was involved in CCA and/or DRR issues. It was not possible, however, to control if answers were achieved unanimously. This might have introduced a self-perception bias in the SNA, since respondents' subjective responses provide the factual input to the interaction analysis. Using alternative methods, such as focus groups, could potentially limit this barrier.

(f) **Interpretation of SNA results:** SNA is a suitable tool for exploring social structures and the interaction patterns among different actors. Nevertheless, it has limited potential when trying to explain the reasons why such structures or patterns exist, why actors have certain roles, or relate to each other the way they do. Complementary use of the SNA with other methodological tools (e.g., in-depth interviews as seen in this study) can result in a more insightful interpretation of the results that emerge from its application. Similarly, the design of multi-level SNA exercises, which combine 'whole-network' and 'ego-network' analyses (see [29,30]) has the potential to provide a better understanding of the networks both in terms of the roles of the actors they entail as well as of their interactions.

(g) **Network dynamics:** SNA exercises, such as the one presented here, are rather static and can capture only a snapshot in time. At the same time, networks (i.e., actor interactions and the roles they have in a network) are rather dynamic and responsive to changes in their composition and the overall context in which they operate. A regular repetition of such exercises [29,36], both the 'monitoring' of the preliminary inventory of actors and the SNA exercise itself, can help understand how networks evolve over time.

In spite of the above-mentioned challenges, the value and usefulness of the SNA should not be undermined. SNA has the potential to provide objective (quantitative) information on how actors are interrelated and the roles they play in networks through systematic and scientifically robust

methods. Such information can be used to inform a practical strategy to support the improvement of the interactions and the coherence between different communities of interest.

3.5. Recommendations

Even if efforts to close the gap between the two communities have already been implemented, evidence of an insufficient alignment of the two fields is still present. Existing barriers restrict a more effective communication and collaboration between the two communities, which are seen to operate to a large extent in silos. SNA results along with the information collected through the in-depth interviews allowed for the formulation of a tentative set of recommendations for improving actors' collaboration, subject to further empirical testing:

(a) Coherence between the two communities can be achieved through knowledge sharing. Engaging in this process actors with high out-degree centrality values (e.g., Climate-ADAPT and DG RTD), which indicate their strong interest in outreach activities, could have a positive impact on knowledge dissemination, contributing to the development of stronger ties between the two communities.

(b) The exercise presented in this paper was meant to foster dialogue and support partnerships among stakeholders with similar or complementary interests. Feedback received during the survey confirmed the achievement of this goal and highlighted the need for closer cooperation.

(c) The importance of having diverse opinions in CCA and DRR dialogues has already been acknowledged, especially when thinking of ways to enhance synergies between different communities at stake [1]. Although it has been observed that actors seek to interact with other actors with whom they share some similarities (i.e., homophily), ensuring diversity in a network is expected to be of benefit in terms of its potential to expand, increasing its strength and relevance in the longer term.

(d) Future research should focus on actors that have key roles in their networks (e.g., actors with high potential for setting direct interactions with other actors in their networks, and thus for sharing information, or others that have the ability to connect actors that are not well connected with the rest of the network) in order to better understand which of their characteristics or competences have enabled or facilitated their interactions with other actors. Similarly, it is important to identify and investigate the profiles of actors that have a low number of connections, in an attempt to develop solutions to overcome this barrier. Egocentric SNA, as seen in other studies [30], might be a useful approach for this purpose, as it provides useful insights in the type of interactions of distinct actors.

(e) Involving actors that are often neglected in relevant exercises is important for multiple reasons. Perhaps the most important reason is that placing less known, yet important, actors on the map of the CCA/DRR landscape increases their visibility. This is the starting point for any type of interaction; either by providing a simple awareness of their existence by other actors, setting the ground for the beginning of their communication with others, or in a more optimistic scenario, helping them establish strong and fruitful collaborations. It is acknowledged, however, that introducing new actors in established networks is not always a trivial task [50] and may require systematic efforts before such changes are achieved and fully accepted.

(f) Finally, efforts should be placed on emphasising and promoting the complementarity of both different fields and resulting benefits through a joint resilience narrative. This would support the development of a mutual understanding and foster shared goals and networks of collaborative actions. In the case of the CCA and DRR communities, institutions that aim to fill in existing gaps, overcome barriers, and, finally, bring the two communities closer need to have strong motivation and commitment, and to show patience and perseverance, as the alignment of interests is a rather time-consuming process with a considerable risk of failure.

4. Conclusions

Climate change adaptation (CCA) and disaster risk reduction (DRR) are fields of research, policy, and practice relevant for multiple sectors and governance. Although they pursue complementary objectives, they have different structures and different policies [19], and thus are characterised by different norms and value systems. Such formative differences can hardly be bridged by legislation or financial incentives alone. They need effective communication and collaboration to overcome the lack of a common conceptual apparatus and shared objectives, and support the establishment of common practices and the development of synergies between them.

The SNA presented in this paper aimed at improving the understanding of the way that 35 key CCA and DRR actors active in Europe interact with each other. Communication and collaboration were found to exist both within and between the CCA and DRR groups. In relative terms, communication appears to be stronger within groups, while collaboration is also relatively relevant between them. The existence of two "communities" corresponding to actors involved mainly in CCA or in DRR activities was confirmed both in the SNA and follow-up interviews. The allocation of actors to the two groups was not rigid and variations could be observed depending on the applied algorithms and the considered indicators. Overall actors tied with DRR related connections were more prone to clustering, i.e., they had a recognisable pattern of connections, while CCA and mixed related connections were more diverse, without an obvious clustering affinity.

The exercise identified actors with a strong role in the studied network. The European Climate Adaptation Platform, Climate-ADAPT, had the highest value for various SNA metrics, reflecting its popularity in the network and its potential for enhancing interactions among its actors. Other EU institutions, research institutes, and international bodies had prominent roles in the considered network, along with some international networks, platforms, and representatives of the private sector.

Although SNA revealed overall a well-connected network, in-depth interviews described communication between both communities as insufficient, while emerging collaboration was traced back to flagship projects and initiatives to connect both domains, which are still rare. Follow-up interviews also pointed at a possible perception bias related to actors who do not identify with a specific group (CCA or DRR) but are an integral part of it from the perspective of their counterpart. This suggests that interactions between CCA and DRR communities may be more frequent in reality than indicated in the SNA. As in most complex systems, several factors may hinder constructive interactions between CCA and DRR. It is important to understand such dynamics and to draw tentative recommendations that would support communication and collaboration interactions between the CCA and DRR communities, and ultimately enhance the alignment of the two domains and their relevant initiatives.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. List of actors invited to participate in the online SNA survey.

No.	Actor's Name	Actor's Acronym
1	European Climate Adaptation Platform	Climate-ADAPT
2	Climate Adaptation Services	CAS
3	Climate Knowledge and Innovation Community	Climate-KIC
4	Climate Knowledge Brokers Group	CKB
5	Covenant of Mayors	Covenant of Mayors
6	Copernicus Climate Change Service	C3S
7	Directorate General for Climate Action	DG CLIMA
8	EU Humanitarian Aid and Civil Protection department	DG ECHO
9	Directorate General for Research and Innovation	DG RTD
10	Disaster Risk Management Knowledge Centre	DRMKC
11	Environment and Climate Regional Accession Network – ECRAN	ECRAN
12	The Heads of European Nature Conservation Agencies ENCA – CCA	ENCA – CCA
13	EPANet	EPANet
14	European Commission Joint Research Centre	JRC
15	European Environmental Agency	EEA
16	ICLEI Europe	ICLEI Europe
17	International Federation of Red Cross and Red Crescent Societies	IFRC
18	International Institute for Applied Systems Analysis	IIASA
19	Intergovernmental Panel on Climate Change	IPCC
20	Climate Joint Programming Initiative	JPI Climate
21	JPI Urban Europe	JPI Urban Europe
22	Munich Re	MunichRe
23	PERILS	PERILS
24	Platform on Natura Hazards of the Alpine Convention	PLANALP
25	PreventionWeb	PreventionWeb
26	PREVIEW	PREVIEW
27	PROVIA	PROVIA
28	Pyrénéen du Changement Climatique (eng. Pyrenees Climate Change Observatory	OPCC
29	SwissRe	SwissRe
30	Inter-agency Working Group on CC and DRR	Inter-agency Working Group on CC and DRR
31	UNISDR Europe	UNISDR Europe
32	UNISDR STAG	UNISDR STAG
33	United Nations Environment Programme (Currently: United Nations Environment)	UNEP (Currently: UN Environment)
34	United Nations Development Programme	UNDP
35	weADAPT	weADAPT

Appendix B

Full SNA Questionnaire

Your interactions with other actors

Q. 1 Having in mind the organisation that you represent (e.g., institution/initiative/network/platform), please make an assessment of your interaction with the other actors included in the list below by selecting on the scale 1-5, and indicate if the interaction is related to Climate Change Adaptation (CCA), Disaster Risk Reduction (DRR), or both. Please provide a response for all the entries of the list. No response will be interpreted as: "I am not aware of this actor".

The meaning of the scale is the following:

1 – I am aware of this actor, but to my knowledge, we do not have any contacts with this actor

2 – Myself and/or my colleagues communicate with this actor from time to time

3 – Myself and/or my colleagues have frequent communication exchanges with this actor

4 – Myself and/or my colleagues collaborate with this actor from time to time

5 – Myself and/or my colleagues have regular and/or institutional collaborations with this actor

Please type the name of the organisation that you represent: … … …

How would you characterise and assess your interaction with the following actors in the fields of DRR and CCA?

a. Intensity of interaction: Drop down menu including options 1-5 mentioned above

b. Type of interaction: Drop down menu including the three following options:

predominantly related to CCA, predominantly related to DRR, related both to CCA and DRR

If you have any feedback that you would like to share with us, including other important DRR/ CCA actors to be considered in future activities, please use the comment box below.

Appendix C

Table A2. Actors' ranking based on the calculated SNA metrics. Actors marked in bold indicate the actors that participated in the interviews.

SNA Ranking	Degree Centrality	In-degree Centrality	Betweenness Centrality	Eigenvector Centrality
1	Climate-ADAPT (50)	DG CLIMA (27)	**Climate-ADAPT** (101.815)	**DG RTD** (0.043)
2	DG RTD (47)	EEA (25)	DG RTD (52.863)	**Climate-ADAPT** (0.043)
3	EEA (46)	IPCC (24)	DG CLIMA (45.396)	**DG CLIMA** (0.041)
4	DG CLIMA (46)	JRC (23)	EEA (34.670)	UNEP (0.039)
5	UNISDR Europe (43)	UNEP (22)	JRC (27.886)	**UNISDR Europe** (0.038)
6	IPCC (39)	PreventionWeb (22)	UNEP (24.510)	**EEA** (0.038)
7	UNEP (38)	**Climate-ADAPT** (22)	IPCC (22.166)	**PreventionWeb** (0.037)
8	PreventionWeb (35)	UNISDR Europe (20)	UNISDR Europe (21.106)	**IPCC** (0.037)
9	IIASA (34)	UNDP (19)	EPANet (21.019)	IIASA (0.037)
10	JRC (33)	IFRC (18)	IIASA (20.709)	UNISDR STAG (0.035)
11	DG ECHO (33)	DG RTD (18)	SwissRe (17.693)	IFRC (0.035)
12	SwissRe (32)	MunichRe (17)	UNISDR STAG (16.391)	**JRC** (0.034)
13	JPI Climate (32)	DG ECHO (17)	JPI Climate (15.141)	UNDP (0.033)
14	UNISDR STAG (31)	ICLEI Europe (16)	UNDP (13.409)	SwissRe (0.033)
15	MunichRe (31)	SwissRe (15)	PreventionWeb (12.558)	DG ECHO (0.033)
16	IFRC (31)	PROVIA (15)	IFRC (12.105)	JPI Climate (0.032)
17	UNDP (28)	Climate-KIC (14)	Covenant of Mayors (9.556)	MunichRe (0.031)
18	weADAPT (25)	IIASA (13)	MunichRe (8.564)	DRMKC (0.029)
19	DRMKC (25)	UNISDR STAG (12)	DG ECHO (6.765)	CKB (0.029)
20	C3S (24)	C3S (12)	CKB (6.749)	C3S (0.028)
21	CKB (24)	JPI Climate (11)	C3S (6.283)	weADAPT (0.027)
22	PROVIA (22)	Covenant of Mayors (11)	PROVIA (5.211)	PROVIA (0.027)
23	PREVIEW (22)	DRMKC (10)	ICLEI Europe (4.579)	PREVIEW (0.027)
24	Covenant of Mayors (20)	weADAPT (9)	Climate-KIC (3.917)	Inter-agency Working Group on CC and DRR (0.025)
25	CAS (20)	PREVIEW (8)	weADAPT (3.698)	ICLEI Europe (0.025)

Table A2. *Cont.*

SNA Ranking	Degree Centrality	In-degree Centrality	Betweenness Centrality	Eigenvector Centrality
26	EPANet (19)	PLANALP (8)	CAS (3.623)	EPANet (0.025)
27	Inter-agency Working Group on CC and DRR (16)	CKB (8)	DRMKC (3.104)	CAS (0.023)
28	ICLEI Europe (16)	CAS (7)	PREVIEW (2.640)	Covenant of Mayors (0.021)
29	PLANALP (15)	PERILS (6)	Inter-agency Working Group on CC and DRR (1.407)	Climate-KIC (0.021)
30	Climate-KIC (14)	ECRAN (6)	JPI Urban (1.162)	PLANALP (0.019)
31	JPI Urban (12)	OPCC (3)	ECRAN (0.752)	JPI Urban (0.016)
32	ECRAN (12)	JPI Urban (3)	PLANALP (0.285)	ECRAN (0.015)
33	PERILS (9)	EPANet (3)	OPCC (0.154)	OPCC (0.010)
34	OPCC (8)	ENCA -CCA (2)	PERILS (0.111)	PERILS (0.010)
35	ENCA - CCA (2)	Inter-agency Working Group on CC and DRR (1)	ENCA - CCA (0.000)	ENCA - CCA (0.003)

Appendix D

Interview guidelines

Questionnaire on the results of the Social Network Analysis of the PLACARD Project

Your institution turned out to play an important role in the analyzed network. In order to better understand and explain the reasons behind the obtained outcomes we would like to ask you a few additional questions. Thank you in advance for your cooperation.

- ➢ First please make yourself familiar with the attached full list of SNA participants and the obtained results and keep both files within reach.

Q1.
(a) Are the presented SNA results in line with your general expectations?
Does the role of your institution in the network (with regard to five SNA characteristics listed in Table A1) correspond to your perception?

(b) If there are substantial differences between the SNA outcomes and your answers related to expected outcomes: are you positively/ negatively surprised? Why?

Q2. Climate-ADAPT was best rated in terms of its ability to create a bridge between CCA & DRR community. What could be the possible reason for a particularly strong position of the Climate-ADAPT platform in this respect, taking into account that Climate-ADAPT is a platform resulting from a partnership between DG RTG, DG CLIMA, DG JRC and EEA?

Q3. In your opinion, which organizational characteristics and external factors are likely to influence an actor's openness towards the other community in terms of network connections?
Is it the organization's mission/vision including interdisciplinary work approach, experience in inter-organizational cooperation, leadership with excellent organizational and communication skills, organizational resources (e.g., finance, time, physical space, materials, equipment, and skilled personnel) or joint funding, legal requirements to conduct joint projects? Or maybe something else?
Please indicate which factor(s) play(s) most important role in your opinion (max. 3)

Q4. SNA results show that DRR actors tend to pertain to a single cluster, while CCA actors are generally more spread (See Figure 1). What could be the possible reason for that?

Q5. In terms of type of interactions, we found out that collaboration in our network is most often related to BOTH CCA & DRR, while communication process in many cases tackles JUST ONE of the two areas. What could be the possible explanation for this?

Table A3. Ranking of the top 10 actors with regard to different SNA characteristics (SNA metric values).

Ranking	Having Good and Frequent Communication with Other Actors in the Network and Vice Versa	Best Assessment of Other Actors with Regard to Frequency and Quality of Communication	Ability to Connect CCA and DRR Community	Having Connections to Most Popular Actors in the Network (Popularity Refers to the Number of Connections in the Presented Network)	Being a Part of a Group Whose Members Are Tightly Connected to Each Other
1	Climate-ADAPT	DG CLIMA	Climate-ADAPT	Climate-ADAPT, DG RTD	ENCA-CCA
2	DG RTD	EEA	DG RTD	DG CLIMA	OPCC
3	EEA, DG CLIMA	IPCC	DG CLIMA	UNEP	PLANALP
4	UNISDR Europe	JRC	EEA	EEA, UNISDR Europe	ECRAN
5	IPCC	Climate-ADAPT, UNEP, PreventionWeb	JRC	IPCC, IIASA, PreventionWeb	PERILS
6	UNEP	UNISDR Europe, UNDP	UNEP	IFRC, UNISDR STAG	PREVIEW
7	PreventionWeb	DG RTD, IFRC CC	IPCC	JRC	DRMKC
8	IIASA	DG ECHO, MunichRe,	UNISDR Europe	DG ECHO, SwissRe, UNDP	MunichRe
9	JRC, DG ECHO	ICLEI Europe	EPANet	JPI Climate	JPI Urban
10	UNISDR STAG, JPI Climate, SwissRe	PROVIA, SwissRe	IIASA	MunichRe	ICLEI Europe

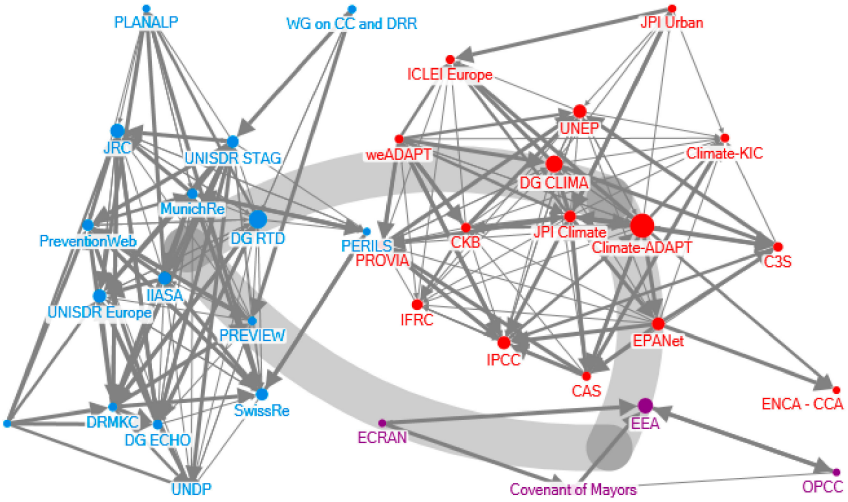

Figure A1. Cluster analysis of stakeholder and boundary organisations, knowledge platforms, policy and research initiatives, existing networks/partnerships, and end user needs (SPINE) network.

Appendix E

Table A4. Information on actors' competencies and expertise (information on the general description and the core competences of the actors has been derived primarily from the official websites of the organisations).

No	Actor's Name	Brief Description	Core Competences	Field of Expertise
1	Climate-ADAPT	European CCA online platform and reference point to EU climate change impacts, vulnerabilities, adaptation tools, options, and case studies to support Europe in adapting to climate change.	Providing access and sharing information on the following topics: Expected CC in Europe, current and future vulnerability of regions and sectors EU, national and transnational adaptation strategies and actions, adaptation case studies and potential adaptation options, tools that support adaptation planning.	CCA
2	Climate Adaptation Services (CAS)	(. . .) a non-profit organisation that provides user-centred visualisation tools to anticipate the effects of climate change. CAS supports governments, policy makers, and professionals in gaining an understanding of (local) climate impacts and provides methods and tools to support the process of spatial adaptation.	Making climate information accessible and understandable to practitioners: Visualisation of climate change impacts, interpretation of climate scenarios.	Climate research, CCA
3	Climate-Knowledge and Innovation Community (Climate-KIC)	Europe's largest public–private innovation partnership focused on climate change, consisting of dynamic companies, the best academic institutions, and the public sector.' Its mission is to create zero-emission, resilient society. KIC was established in 2001 by European Institute of Innovation and Technology (EIT – EU body).	Integration of education, entrepreneurship, and innovation resulting in connected, creative transformation of knowledge and ideas into economically viable products or services in the following areas: Urban transitions, sustainable production systems, decision metrics and finance, sustainable land use.	CCM, CCA
4	Climate Knowledge Brokers Group (CKB)	An alliance of leading global, regional, and national websites specialised in climate and development information. Its focus is on online initiatives that play an explicit knowledge brokerage role, rather than being simply institutional websites	Developing common tools for an efficient sharing of and searching for climate data, initiating joint projects to connect different websites, test out innovations and generate new thinking on how to best meet user needs, supporting peer learning, building capacity by offering hands-on advice to new initiatives being set up, providing leadership to create a focal point and a voice for the community as a whole.	Climate Research

Table A4. *Cont.*

No	Actor's Name	Brief Description	Core Competences	Field of Expertise
5	Covenant of Mayors	World's biggest urban climate and energy initiative'. It consists of regional and local governments that voluntarily commit to fulfil the requirements of EU Climate and Energy framework.	Three main work areas of Covenant of Mayors (as agreed in October 2015) are: Mitigation, adaptation, and securing sustainable and affordable energy	CCM, CCA, Sustainability
6	Copernicus Climate Change Service (C3S)	Earth observation programme coordinated and managed by the European Commission. It collects the data from earth observation satellites and in situ sensors such as ground stations, airborne, and sea-borne sensors and processes these data to provide users with reliable and up-to-date information through a set of services related to environmental and security issues. Established in 2014	Copernicus services address the following thematic areas: Environment protection, management of urban areas, regional and local planning, agriculture, forestry, fisheries, health, transport, climate change, sustainable development, civil protection, and tourism.	Climate Services, CCA
7	DG CLIMA (Directorate General for Climate Action)	DG CLIMA is in charge of the EU climate policy. In particular, it prepares and implements EU-wide climate regulations, it participates in international climate negotiations, supervises implementation of the EU ETS, and monitors national emission levels. Last but not least, DG CLIMA propagates green technologies and their implementation. This directorate was founded in 2010.	Specific tasks performed by specialised DG CLIMA units include: (a) International mainstreaming (e.g., implementation of the Paris Agreement, climate finance, mainstreaming of the Montreal Protocol) (b) European and international carbon markets (c) Climate strategy, governance and emissions from non-trading sectors (d) Shared resources. In particular, Unit A3 Adaptation is responsible for the implementation of the adaptation policy and strategy in order to develop climate resilience, incorporation of the adaptation into other policy areas such as water or infrastructure, promotion of climate adaptation actions in the climate negotiations and among least developed countries as well as its acknowledgement in specific funds.	CCM, CCA

Table A4. *Cont.*

No	Actor's Name	Brief Description	Core Competences	Field of Expertise
8	DG ECHO (EU Humanitarian Aid and Civil Protection department)	DG ECHO aims to save and preserve life, prevent and alleviate human suffering, and safeguard the integrity and dignity of populations affected by natural disasters and man-made crises.	Two pillars of work of DG ECHO are humanitarian aid and civil protection. Within the first category, DG ECHO deals with many different topics ranging from refugee help to international humanitarian law. Particularly important to PLACARD are the following topics: Resilience, disaster risk reduction, and capacity building. Within the second category, DG ECHO manages EU Civil protection mechanism, Emergency Response Coordination Center, monitoring tools, etc.	Humanitarian Aid, DRR
9	DG RTD (Directorate-General for Research and Innovation)	DG RTD is in charge of the innovation policy with the overall aim of creating an Innovation Union. Its long-term objectives include boosting EU competitiveness, job creation, and dealing with main societal challenges (incl. CC).	The work of DG RTD includes: The analyses of national R&I policies, provision of recommendations, creation and implementation of the European Research Area, funding research and innovation through corresponding Framework Programmes such as FP7 or H2020.	Research and Innovation
10	Disaster Risk Management Knowledge Centre (DRMKC)	European Commission's initiative to improve and deepen the communication between policy makers and scientists in the field of disaster risk management.	Translation of complex scientific data and analyses into usable information, (. . .) science-based advice for DRM policies, as well as timely and reliable scientific-based analyses for emergency preparedness and coordinated response activities. It brings together existing initiatives in which science and innovative practices contribute to the management of disaster risks	DRR
11	Environment and Climate Regional Accession Network – ECRAN	EU-financed and EC-managed programme that supports cooperation between EU and prospective EU candidate countries in the area of environmental and climate protection as well as the alignment of their policies and actions to the EU standards. The work of ECRAN is conducted in three WPs related to environment, climate action, and cross-cutting issues (such as enforcement and compliance or public participation).	Facilitation of exchange of information and promotion of best practices related to the EU accession and corresponding environmental requirements. In particular, the Adaptation Working Group aims to encourage development and implementation of adaptation policies in the beneficiary countries, to make economic sectors incl. infrastructure 'climate proof', to improve adaptation decision making process and connect it to WeAdapt.	Environmental protection, CCM, CCA

Table A4. *Cont.*

No	Actor's Name	Brief Description	Core Competences	Field of Expertise
12	The Heads of European Nature Conservation Agencies ENCA – CCA	ENCA is (...) an informal network, which aims to strengthen nature conservation in Europe by enhancing cooperation and collaboration between its members.	Supporting policy development, establishing a forum for sharing information, experiences and best practices, strengthening scientific evidence base to improve decision making in the field of nature conservation and landscape protection.	Environmental protection, Nature conservation
13	EPANet	Interest Group of European Network of Heads of Environment Protection Agencies (EPANet)	Investigating, in detail, issues related to CC and CCA important to the network.	CCA
14	European Commission Joint Research Centre (JRC)	JRC is European Commission's science and knowledge service, which employs scientists to carry out research in order to provide independent scientific advice and support to EU policy.	Providing independent scientific evidence to the EU policymaking process, collaboration with scientific institutions.	Civil protection, Environmental protection
15	European Environmental Agency (EEA)	EU institution to provide information to those involved in developing, adopting, implementing and evaluating environmental policy, and also to the general public. An important field of work of EEA is climate change (mitigation and adaptation). Established in 1990, entered into force 1993.	Helping the Community and Member Countries make informed decisions about improving the environment, integrating environmental considerations into economic policies and moving towards sustainability, coordination of the European environment information and observation network Eionet (http://www.eionet.europa.eu/)	Environmental protection, Sustainability
16	ICLEI Europe	ICLEI is the only network of sustainable cities operating worldwide. The organisation facilitates local government input to United Nations (UN), processes such as the UN Framework Conventions on Climate Change, and Biodiversity. In partnership with the UN and other organisations, as well as national governments, ICLEI puts in the groundwork for more ambitious and more responsible international commitments—and seeks global recognition and support for local action.	Facilitating strategic alliances, advocacy, exchange of experiences and best practices, organisation of campaigns and programmes, provision of tools and technical trainings to enable sustainable growth.	(Urban) Sustainability

Table A4. *Cont.*

No	Actor's Name	Brief Description	Core Competences	Field of Expertise
17	International Federation of Red Cross and Red Crescent Societies (IFRC)	IFRC carries out relief operations to assist victims of disasters, and combines this with development work to strengthen the capacities of its member National Societies. The IFRC's work focuses on four core areas: Promoting humanitarian values, disaster response, disaster preparedness, and health and community care.	Crisis relief, disaster risk management, preparedness, capacity building.	Humanitarian Aid, DRR, CCA
18	International Institute for Applied Systems Analysis (IIASA)	International independent scientific organisation conducting research on policy-relevant topics such as global environmental, economic, technological, and social change and providing guidance to policymakers. Its goal is to protect the environment and improve social wellbeing. IIASA was founded in 1972 and it has been funded by research funding agencies	Research on specific solutions to complex problems (e.g., CC) that affect countries' economies, environment and society, creation of research base for systems analysis, developing multilateral scientific relationships. One of its main strategic research themes is Risk and Resilience.	Sustainability
19	Intergovernmental Panel on Climate Change (IPCC)	Leading international body for the assessment of climate change established by UNEP and WMO (. . .) to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts.	Review and assessment of the most recent scientific, technical, and socio-economic information produced worldwide relevant to the understanding of climate change.	CCM, CCA
20	Climate Joint Programming Initiative (JPI Climate)	(. . .) Collaboration between 14 EU Member States to coordinate their climate research and fund new transnational research initiatives. It connects scientific disciplines, enables cross-border research and increases the science-practice interaction.	User-driven development and provision of knowledge for understanding the climate, climate change and its impacts, as well as guidance in its use.	Climate change research

Table A4. *Cont.*

No	Actor's Name	Brief Description	Core Competences	Field of Expertise
21	JPI Urban Europe	'As one of the resulting joint programming initiatives the JPI Urban Europe was created in 2010 to address the global urban challenges of today with the ambition to develop a European research and innovation hub on urban matters and create European solutions by means of coordinated research	Supporting (. . .) transition of European urban areas towards sustainable, resilient, and liveable ones by establishing a transnational mission-oriented research, technological development, and innovation programme and acting as the European hub on sustainable urban development; supporting collaborative research, technological development and innovation within and beyond Europe.	Urban development, (Urban) Sustainability
22	MunichRe	One of the world's leading reinsurers funded in 1880 in Munich.	Risk assessment, risk transfer solutions, assessment management.	Insurance
23	PERILS	Insurance industry initiative aimed at improving the availability of catastrophe insurance market data. PERILS' industry data are based on information exclusively received from insurance companies writing business in the territories covered by PERILS. The industry benchmark data are available to all interested parties via a subscription service.	Industry exposure and event loss data, and an associated industry loss index service for windstorm in Europe, flood in UK, earthquake and flood in Italy, and earthquake and flood in Turkey.	Risk Assessment
24	Platform on Natural Hazards of the Alpine Convention (PLANALP)	PLANALP 'was set up as part of Alpine Convention to develop common strategies designed to prevent natural hazards in the Alps as well as to exchange on adaptation strategies	Formulation of strategic concepts on integrated risk management against natural hazards and the coordinated implementation of subsequent measures, knowledge transfer and exchange of best practices, implementation of flood (risk) management plans, propagating the use of standards for natural hazards and risk.	CCA, DRR
25	PreventionWeb	'participatory web platform for the disaster risk reduction community', created by UNISDR.	facilitation of an understanding of the subject of disaster risk reduction (DRR) and the work of professionals in this area by providing current news and views on the topic, and tools for exchange and collaboration.'	DRR

Table A4. *Cont.*

No	Actor's Name	Brief Description	Core Competences	Field of Expertise
26	PREVIEW	The PREVIEW Global Risk Data Platform is a multiple agencies effort to share spatial data information on global risk from natural hazards. Users can visualise, download, or extract data on past hazardous events, human and economical hazard exposure, and risk from natural hazards. (. . .), developed as a support to the Global Assessment Report on Disaster Risk Reduction (GAR).	Providing spatial data information on natural hazards.	Risk Assessment and Exposure
27	PROVIA	(. . .) Global initiative, which aims to provide direction and coherence at the international level for research on vulnerability, impacts, and adaptation.' It acts as a 'network of scientists, practitioners and decision-makers working towards identifying research gaps and meeting policy needs.	Advancing policy-relevant research on vulnerability, impacts, and adaptation related to climate change, dissemination, and practical application of this research for the benefit and value of society.	CCA
28	Pyrénéen du Changement Climatique (OPCC) (eng. Pyrenees Climate Change Observatory)	Working Community of the Pyrenees is a consortium of 8 territorial governments (7 sub national governments and one national government) launched in 2010 the Pyrenees Climate Change Observatory. The OPCC's goal is to monitor and understand the climate evolution in the Pyrenees, with the aim of becoming less vulnerable to the impacts of climate change, and adapting to its effects by defining appropriate adaptation strategies for socio- economic sectors and the most fragile natural areas.	The objectives of the OPCC are the following: (1) Gathering the existing knowledge on impact of CC in the Pyrenees and identifying knowledge gaps, (2) analysing vulnerability in the region and its socio-economic impact, (3) provision of recommendations concerning adaptation to climate change to ensure sustainable development, (4) education of population, (5) propagation of adaptation and observation measures taken in the Pyrenees.	Sustainability, CCA

Table A4. *Cont.*

No	Actor's Name	Brief Description	Core Competences	Field of Expertise
29	SwissRe	Re-insurance and risk expertise provider established in 1863. Its goal is to make the world a more resilient place.	Operation of databases on disasters and loss and damage, developing models to predict future events and their potential impact, calculation of the corresponding risk premium	Insurance
30	Inter-agency Working Group on CC and DRR	This group was established to share information between the disaster risk reduction and climate change communities. It has been supported by UNISDR and co-chaired by UNDP and WMO.	Gathering and sharing good practices in climate risk-reduction, providing policy guidance to UNFCCC processes on the post-2012 climate change regime and developing methods for reducing the carbon footprint of disaster risk reduction activities.	DRR, CCA
31	UNISDR Europe	UNISDR regional office for Europe	(...) Ensuring disaster risk reduction (DRR) is applied to climate change adaptation, increasing investments for DRR, building disaster-resilient cities, schools, and hospitals, and strengthening the international system for DRR.	DRR
32	UNISDR STAG	The purpose of the STAG is to provide 'technical advice and support in the formulation and implementation of activities carried out by the disaster risk reduction community.' The work of the STAG encompasses all aspects of the scientific and technical dimensions of risk reduction, with particular emphasis on the needs of developing countries. STAG consists of up to 20 representatives of the institutions involved in the Scientific and Technical Partnership and a couple of individual experts.	Improving policymaking and practice by the means of scientific research, interdisciplinary multi-hazard research, translation of science into practice, bringing together national and regional DRR platforms and networks.	DRR

Table A4. *Cont.*

No	Actor's Name	Brief Description	Core Competences	Field of Expertise
33	United Nations Environment Programme (UNEP)	Environmental authority of the UN responsible for setting the global environmental agenda and promotion of the coherent implementation of the environmental dimension of sustainable development. Its field of work encompasses dealing with climate change (incl. CCA especially in the developing world) and disasters and conflicts (incl. DRR). UNEP works also on mainstreaming eco-based disaster risk reduction (Eco-DRR) into climate adaptation strategies.	Assessing global, regional, and national environmental conditions and trends, developing international and national environmental instruments, strengthening institutions for the wise management of the environment, field-testing of Eco-DRR solution, promotion of sustainable and resilient development.	Environmental protection, CCA, (Eco-) DRR
34	United Nations Development Programme (UNDP)	UNDP aims to fight poverty, inequality, and exclusion. It supports countries in developing corresponding policies to build reliance and in achievement of Sustainable Development Goals. Its area of work relates to the consequences of climate change and disaster risk reduction.	UNDP's main areas of work include: Sustainable development, democratic governance and peace-building, climate and disaster resilience	Development cooperation, Sustainable Growth
35	weADAPT	Collaborative online 'open space' on climate adaptation issues and synergies with mitigation, which allows practitioners, researchers, and policy makers to access credible, high-quality information and to share experiences and lessons learnt.	Facilitation of learning, exchange, collaboration, and knowledge integration with the aim of building a professional community of research and practice on adaptation issues, developing policy-relevant tools and guidance for adaptation planning and decision-making.	CCA

References

1. Klein, R.J.T.; Adams, K.M.; Dzebo, A.; Davis, M.; Siebert, C.K. *Advancing Climate Adaptation Practices and Solutions: Emerging Research Priorities*; Stockholm Environment Institute: Stockholm, Sweden, 2017. Available online: https://www.sei.org/wp-content/uploads/2017/05/klein-et-al-2017-adaptation-research-priorities.pdf (accessed on 6 March 2018).
2. Karali, E.; Mattern, K. Communicating climate change adaptation information using web-based platforms. *Adv. Appl. Sci. Res.* **2017**, *14*, 241–245. [CrossRef]
3. Calliari, E.; Michetti, M.; Farnia, L.; Ramieri, E. A network approach for moving from planning to implementation in climate change adaptation: Evidence from southern Mexico. *Environ. Sci. Policy* **2019**, *94*, 146–157. [CrossRef]
4. Thomalla, F.; Downing, T.; Spanger-Siegfried, E.; Han, G.; Rockström, J. Reducing hazard vulnerability: Towards a common approach between disaster risk reduction and climate adaptation. *Disasters* **2006**, *30*, 39–48. [CrossRef]
5. Aldrich, D.P.; Meyer, M.A. Social Capital and Community Resilience. *Am. Behav. Sci.* **2015**, *59*, 254–269. [CrossRef]
6. Kapucu, N. Interagency communication networks during emergencies: Boundary spanners in multiagency coordination. *Am. Rev. Public Adm.* **2005**, *36*, 207–225. [CrossRef]
7. Kapucu, N. Interorganizational coordination in dynamic context: Networks in emergency response management. *Connections* **2005**, *26*, 33–48.
8. Brown, C.; Shaker, R.R.; Das, R. A review of approaches for monitoring and evaluation of urban climate resilience initiatives. *Environ. Dev. Sustain.* **2016**, *20*, 23–40. [CrossRef]
9. Clay, P.M.; Colburn, L.L.; Seara, T. Social bonds and recovery: An analysis of Hurricane Sandy in the first year after landfall. *Mar. Policy* **2016**, *74*, 334–340. [CrossRef]
10. The Associated Press—NORC, Center for Public Affairs Research. *Two Years after Superstorm Sandy: Resilience in Twelve Neighborhoods*; The Associated Press—NORC: New York, NY, USA, 2014. Available online: www.apnorc.org/PDFs/Sandy/SandyPhase2Report_Final.pdf (accessed on 15 September 2019).
11. EC, European Commission. *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions—An EU Strategy on Adaptation to Climate Change*; (COM (2013) 216 Final, Brussels, 16.04.2013); European Commission: Brussels, Belgium, 2013.
12. UNFCCC, United Nations Framework Convention on Climate Change. *Paris Agreement*; UNFCCC: New York, NY, USA, 2015. Available online: https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf (accessed on 15 September 2019).
13. UN, United Nations. *Resolution Adopted by the General Assembly on 25 September 2015 70/1. Transforming Our World: The 2030 Agenda for Sustainable Development*; UN: New York, NY, USA, 2015. Available online: https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E (accessed on 15 September 2019).
14. UNISDR, United Nations Office for Disaster Risk Reduction. *Coherence and Mutual Reinforcement between the Sendai Framework for Disaster Risk Reduction 2015–2030 and International Agreements for Development and Climate Action*; UNISDR: New York, NY, USA, 2015. Available online: http://www.unisdr.org/files/45001_unisdrcoherenceandmutualreinforceme.pdf (accessed on 15 June 2019).
15. UNISDR, United Nations Office for Disaster Risk Reduction. *Sendai Framework for Disaster Risk Reduction 2015–2030*; The United Nations Office for Disaster Risk Reduction (UNISDR): New York, NY, USA, 2015.
16. ETC/CCA, European Topic Centre on Climate Change Impacts, Vulnerability and Adaptation. Monitoring, Reporting and Evaluation of National Level Adaptation in Europe: Lessons and Experiences from Other Policy Domains; ETC/CCA Working Paper, No 1/2017. Available online: http://cca.eionet.europa.eu/docs/WP_1-2017 (accessed on 15 May 2019).
17. ETC/CCA, European Topic Centre on Climate Change Impacts, Vulnerability and Adaptation. Indicators for Adaptation to Climate Change at National Level—Lessons from Emerging Practice in Europe; ETC/CCA Technical Paper 2018/3. Available online: https://cca.eionet.europa.eu/reports/TP_3-2018 (accessed on 15 May 2019).
18. EEA, European Environment Agency. *Climate Change Adaptation and Disaster Risk Reduction in Europe. Enhancing Coherence of the Knowledge Base, Policies and Practices*; EEA Report No 15/2017; EEA, European Environment Agency: København, Denmark, 2017; ISSN 1977-8449.

19. Mysiak, J.; Castellari, S.; Kurnik, B.; Swart, R.; Pringle, P.; Schwarze, R.; Wolters, H.; Jeuken, A.; van der Linden, P. Brief communication: Strengthening coherence between climate change adaptation and disaster risk reduction. *Nat. Hazards Earth Syst. Sci.* **2018**, *18*, 3137–3143. [CrossRef]
20. Hildén, M.; Boteler, B.; Capriolo, A.; Castellari, S.; Giordano, F.; Jensen, A.; Karali, E.; McGlade, K.; Mäkinen, K.; Nielsen, H.; et al. Policy Integration and Knowledge Use in the EU Adaptation Strategy. (BASE-WP2, D 2.1). 2013. Available online: https://base-adaptation.eu/sites/default/files/Deliverable_2_1.pdf (accessed on 20 September 2019).
21. Aldrich, D.; Page, C.; Paul, C.J. Social Capital and Climate Change Adaptation. 2016. Available online: http://climatescience.oxfordre.com/view/10.1093/acrefore/9780190228620.001.0001/acrefore-9780190228620-e-342 (accessed on 17 March 2018).
22. Joseph, O.; Fred, M.I.; Philip, N.; William, O.; Gerald, M. Applying social network analysis, centrality measures in identification of climate change adaptation opinion leaders. *IJARIT* **2016**, *6*, 1–7. [CrossRef]
23. Varda, D.M.; Forgette, R.; Banks, D.; Contractor, N. Social Network Methodology in the Study of Disasters: Issues and Insights Prompted by Post-Katrina Research. *Popul. Res. Policy Rev.* **2009**, *28*, 11–29. [CrossRef]
24. Ingold, K.; Balsiger, J.; Hirschi, C. Climate change in mountain regions: How local communities adapt to extreme events. *Local Environ.* **2010**, *15*, 651–661. [CrossRef]
25. Luthe, T.; Wyss, R.; Schuckert, M. Network governance and regional resilience to climate change: Empirical evidence from mountain tourism communities in the Swiss Gottard region. *Reg. Environ. Chang.* **2012**, *12*, 839–854. [CrossRef]
26. Vignola, R.; McDaniels, T.L.; Scholz, R.W. Governance structures for ecosystem-based adaptation: Using policy-network analysis to identify key organisations for bringing information across scales and policy areas. *Environ. Sci. Policy* **2013**, *31*, 71–84. [CrossRef]
27. Akama, Y.; Chaplin, S.; Fairbrother, P. Role of social networks in community preparedness for bushfire. *IJDRBE* **2014**, *5*, 277–291. [CrossRef]
28. Corlew, L.K.; Keener, V.; Finucane, M.; Brewington, L.; Nunn-Crichton, R. Using social network analysis to assess communications and develop networking tools among climate change professionals across the Pacific Islands region. *Interv. Psychosoc.* **2015**, *24*, 133–146. [CrossRef]
29. McCann, H.; Fünfgeld, H.; Brown, J.; Wylie, R. *Social Networks and Disaster Resilience: An Introduction*; report prepared for the Enhancing Networks for Resilience Project; Southern Grampians Glenelg Primary Care Partnership: Hamilton, Australia, 2016. Available online: http://sggpcp.com/projects/enhancing-networks-for-resilience/ (accessed on 15 September 2019).
30. Bojovic, D.; Giupponi, C. Understanding the dissemination and adoption of innovations through social network analysis: Geospatial solutions for disaster management in Nepal and Kenya. *J. Environ. Plann. Man.* **2019**, 1–24. [CrossRef]
31. Karali, E.; Giupponi, C.; Bojovic, D.; Coninx, I.; Calliari, E.; Allenbach, K.; Downing, C.; Rohat, G.; Michalek, G.; Schwarze, R.; et al. Final Release of the Network Database and Associated Documentation (PLACARD Deliverable D 2.2). 2018. Available online: https://www.placard-network.eu/wp-content/PDFs/PLACARD-SNA-phase2.pdf (accessed on 13 December 2019).
32. Giupponi, C.; Biscaro, C. Vulnerabilities-bibliometric analysis and literature review of evolving concepts. *Environ. Res. Lett.* **2015**, *10*, 123002. [CrossRef]
33. Bharwani, S.; Downing, T.E.; Varela-Ortega, C.; Blanco, I.; Esteve, P.; Carmona, G.; Taylor, R.; Devisscher, T.; Besa, C.; Tainio, M.; et al. Social Network Analysis: Decision Support Methods for Adaptation, MEDIATION Project, Briefing Note 8. 2013. Available online: https://mediamanager.sei.org/documents/Publications/sei-mediation-briefing8-social-network-analysis.pdf (accessed on 17 August 2019).
34. Wetherell, C.; Plakans, A.; Wellman, B. Social networks, kinships and community in Eastern Europe. *JIH* **1994**, *24*, 639–663. [CrossRef]
35. Wasserman, S.; Faust, F. *Social Network Analysis: Methods and Applications*; Cambridge University Press: Cambridge, MA, USA, 1994.
36. Krupa, M.; Cenek, M.; Powell, J.; Trammell, E.J. Mapping the Stakeholders: Using Social Network Analysis to Increase the Legitimacy and Transparency of Participatory Scenario Planning. *Soc. Nat. Resour.* **2018**, *31*, 136–141. [CrossRef]
37. Alexandrescu, F.M.; Rizzo, E.; Pizzol, L.; Critto, A.; Marcomini, A. The social embeddedness of brownfield regeneration actors: Insights from social network analysis. *J. Clean. Prod.* **2016**, *139*, 1539–1550. [CrossRef]

38. Szczygiel, N. Yes, We Can? From Intersectoral Partnerships to Quality of Life and User Satisfaction through Patient Centered Care Provision. Ph.D. Thesis, Universidade de Aveiro, Aveiro, Portugal, 2015.
39. Newman, M.E.J. Fast algorithm for detecting community structure in networks. *Phys. Rev.* **2004**, *69*, 066133. [CrossRef]
40. Newman, M.E.J. Detecting community structure in networks. *Eur. Phys. J. B* **2004**, *38*, 321–330. [CrossRef]
41. Newman, M. *Networks: An Introduction*; Oxford University Press: Oxford, UK, 2010.
42. Burt, R.S.; Kilduff, M.; Tasselli, S. Social Network Analysis: Foundations and Frontiers on Advantage. *Annu. Rev. Psychol.* **2013**, *64*, 527–547. [CrossRef]
43. Das, K.; Samanta, S.; Pal, M. Study on centrality measures in social networks: A survey. *SNAM* **2018**, *8*, 13. [CrossRef]
44. EEA, European Environment Agency. *Overview of Climate Change Adaptation Platforms in Europe*; EEA Technical Report. No 5/2015; EEA, European Environment Agency: København, Denmark, 2015; ISSN 1725-2237.
45. EEA, European Environment Agency. *Sharing Adaptation Information across Europe*; EEA Report. No 03/2018; EEA, European Environment Agency: København, Denmark, 2018; ISSN 1977-8449.
46. EC, European Commission. *Commission Staff Working Document. Evaluation of the EU Strategy on Adaptation to Climate Change. Accompanying the Document. Report from the Commission to the European Parliament and the Council on the Implementation of the EU Strategy on Adaptation to Climate Change*; (SWD (2018) 461 final); EC, European Commission: Brussels, Belgium, 2018.
47. Sørensen, J.L.; Carlström, E.D.; Torgersen, G.-E.; Christiansen, A.M.; Kim, T.-E.; Wahlstrøm, S.; Magnussen, L.I. The Organizer Dilemma: Outcomes from a Collaboration Exercise. *Int. J. Disaster Risk Sci.* **2019**, *10*, 261–269. [CrossRef]
48. Jung, K.; Song, M. Linking emergency management networks to disaster resilience: Bonding and bridging strategy in hierarchical or horizontal networks. *Qual. Quant.* **2014**, *49*, 1465–1483. [CrossRef]
49. Magnussen, L.I.; Carlstrøm, E.; Sørensen, J.L.; Torgersen, G.-E. Learning and usefulness stemming from collaboration in a maritime crisis management exercise in Northern Norway. *Disaster Prev. Manag.* **2018**, *27*, 129–140. [CrossRef]
50. Bidwell, D.; Dietz, T.; Scavia, D. Fostering knowledge networks for climate adaptation. *Nat. Clim. Chang.* **2013**, *3*, 610–611. [CrossRef]