

Article

Communities of Innovation for Climate Change Adaptation and Disaster Risk Reduction: Niche Creation and Anticipation

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Abstract: This paper presents the concept of communities of innovation for climate change adaptation and disaster risk reduction. The paper discusses the added value of these types of communities to help address uncertain futures from the impact of climate change, which are highly context dependent. The paper frames these communities of innovation as part of innovation ecosystems in order to reflect on their key elements and added value. We argue that climate change and disaster risk management responses need to meet the needs of those experiencing problems with those that can offer solutions in distinct localities, including those that could fund or finance potential innovative solutions. Developing communities of innovation with the specific task of anticipating and creating niche solutions has been gaining traction in the EU. Some developed under the H2020 BRIGAD project are analysed here for other emergent COIs, as future-oriented communities tasked with the challenge to reduce disaster risks and enhance the climate resilience in their own spaces. This paper reflects on the experience of participants in these communities and their reflections and experience on whether these offer a useful form of organisation to anticipate future challenges, create niche solutions, and bring innovations to the market. The paper concludes with how communities of innovation can contribute to niche design and narratives of change to help achieve social and environmental resilience to reframe and help transition and transform current systems into more resilient, future-oriented communities.

Keywords: climate change; communities; innovation ecosystems; anticipation; niche



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“Innovation will drive the future of our economy. What happens in your community will largely be determined by you. The communities that position themselves to take advantage of the entrepreneurial sector and companies, businesses and individuals that have the education, background, and ability to generate innovation are going to drive the economy in the future. They’re going to create the jobs and the opportunities for our young folks”

STEVE CARTER Iowa State University Research Center and Pappajohn Center for Entrepreneurship.

1. Introduction

Innovation—the development and successful exploitation of new ideas—shapes the future. In addition to its central role in driving societal economic growth, innovation has been recognised as central to achieving wider social and environmental goals [1].

The challenge of adapting to climate change offers an example: the IPCC concludes that achieving the transitions necessary to limit global warming to 1.5°C will depend on “enhanced climate-driven innovation” [2]. Both technological innovation (e.g., development and deployment of new technologies such as remote sensing and early warning systems) and social innovation (e.g., shifts in how we manage our economy and society to reduce vulnerability to high temperatures) will be required to achieve sustainability goals related to the global commons such as climate change mitigation, adaptation, and disaster risk reduction (or DRR). In addition to its central role in adapting to climate, the EU sees the acceleration and spread of innovation as central to Europe’s future economic health and well-being [3].

Despite the need and support for innovation, it is challenging to take socially beneficial innovations from idea to implementation. In part, this arises due to the difficulty of monetising innovation [4]. A second reason is that systemic innovation within the field of sustainability often requires multiple actors for successful implementation, including innovators, scientists, public institutions (e.g., regional governments), local stakeholders, and financiers.

Communities of innovation (COIs) offer a promising organisational form to enable development and implementation of socially beneficial innovation. COIs are one of the most relevant organisational forms to support innovation [5] and are defined as a subset of “communities of practice” that are dedicated to fostering innovation [6]. COIs are social networks, composed of several actors with different skills and positions who share a common goal or aim. They can be geographically focused or dispersed, in which case they would be reliant on digital means of communication. These networks of organisations and individuals combine innovators and scientists, relevant policymakers, funding/financial institutions, and potential buyers, who collaborate to identify challenges and co-develop solutions, with a focus on developing and then implementing new products, processes, and forms of organisation. With their diverse perspectives and expertise, COIs can provide valuable input, feedback, and support for the creation and implementation of innovations. Whilst COIs were initially introduced as a concept for organisations, they have also become a relevant tool for governments to initiate innovative projects for local development [7]. A decisive characteristic is that COIs involve a three-part combination of solution providers (e.g., innovators and researchers), demand side actors (e.g., regional council, citizens, and other stakeholders), and financiers/funders (national and regional government and finance/investment representatives). This transdisciplinary approach supports identification of pressing societal problems; development of socially beneficial innovation; and increased trust, buy-in, and networks that support implementation. This novel approach can also challenge traditional practices, especially in public institutions, in a way that supports future transformational change [8].

The case studies that are used in this paper are harvested from seven COI case studies across Europe. Each COI focused on developing and implementing socially beneficial, impact innovations in the field of climate change adaptation and disaster risk resilience. Data were principally gathered ex-post through phone interviews and an online survey of COI leaders and participants.

This paper aims to contribute to the literature on future oriented innovation and sustainability by clearly defining COIs; identifying success factors and barriers; and assessing their unique usefulness for anticipating, developing, and implementing socially beneficial innovation. Section 2 discusses definitions of COIs and delineates COIs from other forms of organisation for innovation (innovation ecosystems, clusters of innovation, and living labs). Section 3 provides context, introducing the seven COI case studies supporting the paper, and describing the methodology. Section 4 assesses the case study COIs to ascertain identifying characteristics, success factors, and barriers. Section 5 critically assesses whether and how COIs support development and implementation of socially beneficial innovation, including their ability to engage broad communities in the innovation processes.

2. Setting the Scene: What Is a Community of Innovation and How Does It Differ from Other Forms of Organisation for Innovation?

Several papers have addressed the conceptual definition and application of communities of innovation, innovation communities, and communities of practice for innovation [9–11]. In Appendix A, we have included a brief glossary of these other related terms. It is a relatively recent term, linked (as is discussed below) to innovation ecosystems. Our approach in this paper is to first define our key terms, to then present our methods on how we build on the current body of epistemic knowledge on communities of innovation. In our case, we focus on a specific type of community of innovation that—by its very nature—is future oriented since it addresses impacts expected and yet with a high inherent level of uncertainty due to climate change. Thus, a COI operates in an environment with a high level of uncertainty, and which must be highly adaptable and future-oriented to anticipate a changing context, adopting a “proactive” stance, capable of learning in conditions of deep uncertainty. We argue in the final section of the paper that a crucial role of these COIs might lie in the development of innovation niches and the creation of strong narratives of change that help create climate-resilient development pathways for these communities in their respective locations while spearheading new economic models.

For the purposes of this paper, we define communities of innovation as a group of individuals who voluntarily come together to anticipate the need for, develop, and support the implementation of innovations. The organisational form builds on the well-established model of communities of practice, which are “groups of people or organisations who share a concern or a passion for something they do and learn how to do it better as they interact regularly” [12]. COIs are communities of practice that are “dedicated to the support of innovation” [6], where innovation is broadly defined as the “production or adoption, assimilation, and exploitation of a value-added novelty in economic and social spheres; renewal and enlargement of products, services, and markets; development of new methods of production; and the establishment of new management systems. It is both a process and an outcome” [13]. Therefore, there can be communities of innovation in any number of areas. The main advantage in the case of innovation around climate change is the combination of both social and economic, as well as the system renewal aspects, where the system itself must be radically transformed, spurred by both commercial and non-commercial motivations.

The main elements or ingredients defining the COI (see Figure 1) are: first, as champions in their networks; second, as safe places (real or virtual) for the creation and support of innovative ideas; and third, focused focus on a shared future goal, not because of orders from their superiors, but because these different actors form a community convinced on their common cause. COIs feature actors from each part of a triangle that enable impactful development and implementation of socially beneficial innovation:

- Problem owners (demand side): those that face specific problems and the likely end-users of innovations. In the case of climate change impacts such as floods, droughts, or other extreme weather, this includes regional government representatives (who can shape the policy context for the adaptation market and are likely to be end-users and buyers of socially beneficial innovations). This also includes broader stakeholders, e.g., citizens and sectors who will be affected by climate change and therefore can identify adaptation and disaster risk reduction needs and critically assess proposed solutions.
- Solution providers (supply side): innovators, engineers, and scientists, and increasingly also citizens and associations who offer specific solutions to these problems (in our case, climate change impacts), such as, for example, rainwater harvesting for drought; inflatable barriers for floods; or smart roofs that cool houses for, e.g., heat waves. These providers will bring different expertise and approaches to the issues, emerging from all knowledge domains/discipline areas. The dynamic generated because of the trust generated between all actors through regular interaction helps to manage the inherent level of conflict and competition. To build trust, the “leader” of

- the CoI must clearly, concisely, and recurrently (at specific points in the lifetime of the CoI) lay out the options that could be followed to manage any new IP generated.
- Financers/funders: the funder or financier that can financially support or invest in these innovations in their different stages of development (from ideation to replication and upscaling); this includes investors and public funds.

SUCCESS FACTORS

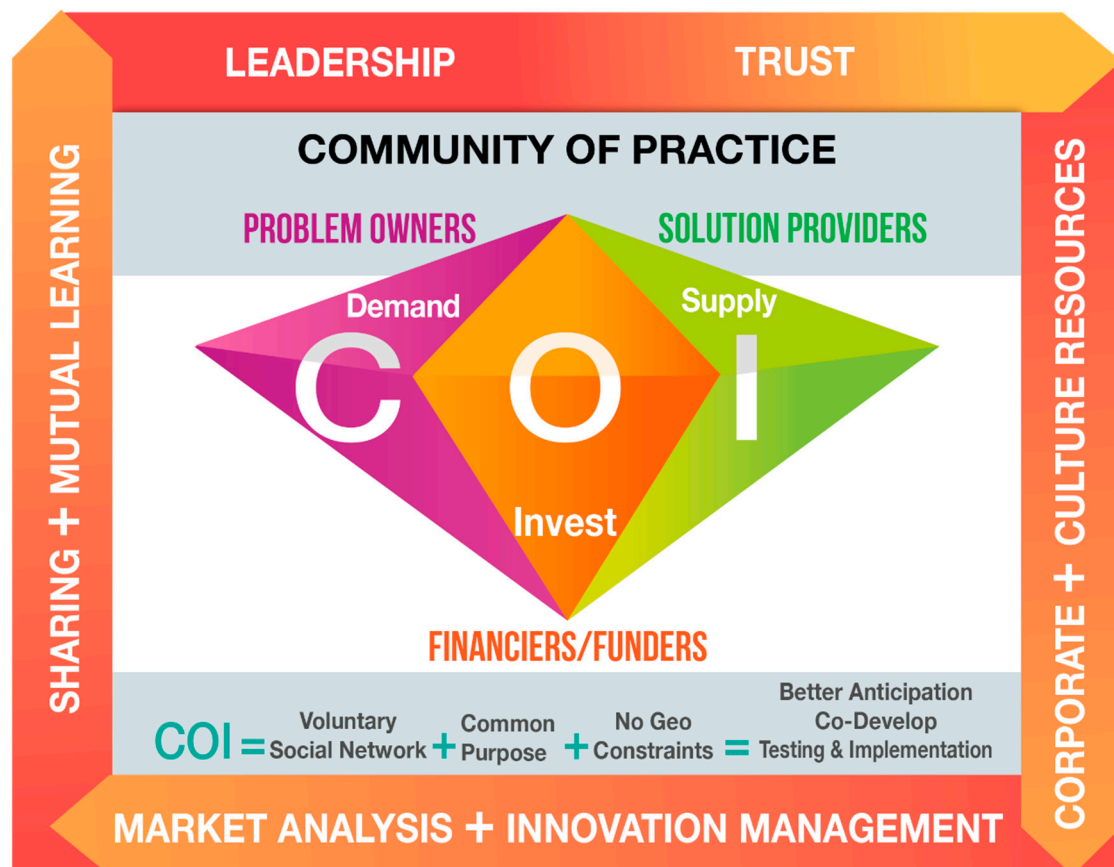


Figure 1. Summary infographic of the key elements of a CoI.

Note, however, that these roles are fluid and sometimes can swap or overlap over time. For example, the demand side actor can become a funder by purchasing initial versions of the innovation or otherwise financing its development. The communities of innovation are first and foremost a social network with a shared purpose. Collectively, these three corners of the triangle (demand, supply, and funding/finance) can better anticipate the need for, co-develop, and support implementation of socially beneficial innovations than each of the actors acting individually.

3. Methodology

A mixed method approach was applied: a literature review helped us to further define the conceptual framework and terminology as presented in the previous section and Appendix B. We then led a series of Samoa circles with experts, and a series of in-depth qualitative interviews. These interviews drew on our sample of seven CoIs that partly emerged and were cultivated as part of the H2020 BRIGAIID project (<https://brigaid.eu/brigaid-connect-innovation-for-resilience/>, accessed on 2 May 2021)

The literature review focused on innovation, communities of practice, and innovation communities. Some important aspects emerge from these papers on the concept of inno-

vation ecosystems [14], innovation systems, and niches of innovation [11]. The literature introduces “artefacts as a part of these innovation (eco)systems, and frames innovation communities as part of innovation systems”. Additionally, the literature identifies that communities of innovations have “agency” in favouring niches of innovation to allow for experimentation, system transformation, and narratives of change [15], supporting sustainable and resilient development pathways.

In the H2020 BRIGAIID project, the communities of innovation were created with the aim of being representative of different types of focus (i.e., climatic hazards) and scale, which are relevant issues to support innovation through the anticipation of likely climate change impacts. Seven COIs were created through the project, involving meetings and end-user-focused workshops (see Table 1).

Table 1. Communities of innovation in H2020 BRIGAIID project.

Communities of Innovation Studied	Hazard	Scale	Climate Change Region
COI Cartagena	Droughts	Regional (Murcia—SP)	Mediterranean
COI Wildfires	Fires	Binational (Spain and Portugal)	Mediterranean
COI Albania	All hazards	National (Albania)	Mediterranean—central eastern Europe
COI Antwerp	Pluvial floods	Local (City of Antwerp—BG)	UK—north coast of central Europe
COI VP Delta	All floods	National (the Netherlands)	UK—north coast of central Europe
COI Venice	Floods	Local (Venice area—IT)	Central western Europe
COI Berlin	Multi-hazard	Local (Berlin—GE)	Central western Europe
COI Rumania	Floods	Local—National (Flood-Proof Romania)	Central eastern Europe

COIs can help to facilitate the market outreach and uptake of innovative and operational products and solutions to climate change adaptation and DRR, which is highly place- and context-specific. To do so, each COI brought together several actors (innovators, end users, leading sectoral users, investors, and societal interest groups) around collectively defined problems (e.g., risk reduction to a specific hazard or cluster of hazards, and environmental conditions). This is based on the premise that “innovation requires involvement from many actors and effective interaction amongst these, whilst recognising the influential role of institutions in shaping how actors interact”. COIs emerged as a set of networks of actors focused on bringing new products, processes, and/or forms of organisation to cope with anticipated future climatic events and therefore to develop suitable adaptation and DRR solutions. To be successful, they had to be open, emergent, and flexible to adapt themselves to dynamic, highly uncertain contexts.

The context was the EU project “BRIGAIID”, which aimed to provide integral support for innovations for climate adaptation by developing and testing methods for improving technical, social, and market readiness of innovations for climate resilience. This approach was complemented by a broad number of market uptake activities at COI scale and also at a broader scale, including a pitch deck program, dissemination of success stories, innovation conferences, and the organisation of innovation fairs. This integrated support allowed for the identification of the best innovation practices from different perspectives, e.g., those based on an active dialogue between end-users and innovators. For example, the development of methodological standards and indicators for monitoring the performance of innovations was positively perceived by actors involved in the innovation process, where matchmaking activities were particularly useful for all actors because it met a need to find adequate spaces and fora where end-users, funders, and innovators could meet. We learnt that supporting the innovation process is central to finding new solutions or adapting existing methods to a new context where classical solutions are starting to fail under rapidly changing conditions. Moreover, end-users required not only innovations that can solve a problem but also that these solutions could be easily operated and maintained with

the available resources and where innovative business models or financing can play an important role in securing the fact that an end-user can support a specific innovation, e.g., specific contracts for the application of an innovation in case specific climatic conditions occur. These key innovation practices have been embedded into the activities undertaken at the COI level throughout the project and were considered in the assessment of the project COIs.

In order to analyse the learnings and reflections from the communities of innovation developed, we led a series of semi-structured 1–2 h interviews with the COI leaders or champions. The interviews assessed the success and impact of the COI to develop an interview questionnaire. To develop the questionnaire, we drew on three expert Samoa circles held between 2017 and 2019 in Cartagena, Spain, held under the BRIGAD Project (October 2018); at Bucharest, Romania, at a Think Nature project meeting side event (September 2019); and at Zaragoza, Spain, held at the European Innovation Partnership side event 8 December 2019) A Samoa circle is a type of a fluid, non-hierarchical exercise to collect ideas and opinions that emerge as the exercise progresses. The three Samoa circles held were centred on identifying the key success factors for a community of innovation. The resulting interview was structured in eight sections:

1. COI introduction: Main goals, spatial focus, and scale of the COIs. This section provided the necessary context to comprehend the activities and responses in the remaining part of the interview.
2. COI composition and structure of the COIs: We asked questions about the organisational structure and the type of stakeholders that were involved in order to understand what type of institutional framework was optimal for both anticipating climate challenges and bringing corresponding solutions to the market. By revealing the key stakeholders in each community and which actor was the key problem owner, we were able to shed light on how the existing network for anticipating climate challenges and bringing corresponding solutions to market needs and the value of different relationships between actors in the COI.
3. Supply of innovations: Assess existing climate adaptation innovations ready for market uptake. Each COI representative was asked to rate their own community on various areas including scouting new opportunities, bringing innovations to market, and developing new business models, as well as timescale of bringing innovations to market and the average “technology readiness levels”.
4. Demand for innovations: Assess need for climate adaptation innovations. The representatives were asked whether there were public funds available to procure the innovations, as well as existing involvement of investors and the main barriers of the public sector and other actors to procure innovations.
5. COI main activities: By reflecting on the underlying activities of the COIs, we understood what type of (social media) platforms, events, or workshops are most effective when dealing with bringing innovations to the market.
6. Key elements of COIs: Qualitative and quantitative assessment of COI success factors. Representatives were asked to rate their own COI on a scale from 1 to 5 on several elements, including characteristics such as leadership, awareness, dialogue facilitation, and trust both between actors within the COI and outwards to the general public.
7. COI outputs: Concrete outputs and areas where COI representatives were most convinced of the potential of COIs. This section focused on the time period of the BRIGAD project.
8. COI learnings: Lessons regarding how COIs can scale up innovations and overcome barriers.

4. Results on Emerging Features in Communities of Innovation

As mentioned earlier, several elements were identified as key descriptors for a COI (see Table 2 below), namely, (i) main goals, hazard, and scale; (ii) composition and structure; (iii) innovations and innovators (supply side); (iv) problem owners (demand side); (v)

investors and funders; (vi) main tasks and activities; (vii) success factors; and (viii) learning and reflections.

Table 2. Key elements analysed in the communities of innovation.

Codes	Key Elements
Aims	Goals Problem ownership
Key elements	Awareness (ground/basic conditions) Facilitation and mediation/ Dialogue Leadership Trust
Space	Spatial focus Scale up the communities of innovations interCOI learning Meeting spaces (virtual or real)
Timescale	Gap between pilot and market
Cross actors	Gap between actors Interdisciplinarity/transdisciplinarity
Triangle	Key actors (innovators, end users and funders/financiers/investors)
Supply—Solutions (innovations)	From the supply side (innovator) Supply side—innovators Early stage TRL (TRL development stages) Middle TRL (TRL development stages) Public funds (early stages of innovation) Code of practice—commitment to development process
Demand—problems	From the Demand side Public Sector
Investors—Risk	From the investor side—effectiveness From the investor side Effectiveness of solutions supplied (insurance they work, guarantees)
Developing a COI	Creating a COI Sustaining a COI COI support Tools

4.1. Main Goals, Hazards Addressed, and Scale

The main goals of the COIs are centred on innovation and the adoption of innovation. Also important is the creation of a collaborative environment and investment into innovation, and cost savings from prevention.

In our COIs, four worked at the national level (Albania, the Netherlands, Romania, and Portugal) and three at regional or local level (Berlin, Venice, and Mar Menor). In most of our COIs, the possibility of scaling up was being considered.

In relation to type of hazards, we considered eight hazards with high potential to increase in Europe under expected climate change conditions, namely, river floods, coastal floods, droughts, heavy precipitation, storms, hail, heatwaves, and wildfires. The results of a high-level scoping exercise about risk vulnerabilities and impacts for three temporal horizons (i.e., 2030, 2050, 2100) have shown the relevance of building a COI as an anticipatory measure to build capacity and resilience as part of preparedness for future anticipated higher climate change impacts in these areas. As an example, the maps produced for wildfire vulnerability identified areas in Germany and Sweden with high adaptive capacity where current wildfire hazards were not relevant although expected to increase, thus creating new market demand. This assessment was confirmed by the increase in wildfires in Sweden in 2018 which were 24 times more widespread in comparison to the average burnt land over the previous 10 years (EU Copernicus Emergency Management Service).

The scale of operation is a relevant variable for the creation of the COIs. Adaptation is often a local or regional process that is based on the application of solutions to deal with specific problems. One of the elements of flexibility in the COIs is that these can also zoom out and can operate at a broader scale. For example, a thematic COI operating at

regional or national scale and supported by a public management body can provide an effective contribution to technology transfer, networking, and dissemination of outputs and innovations. It also involves a higher number of actors, and therefore can draw on a larger critical mass to be effective. Zooming in and out from this top-down or bottom-up processes will often require the contribution of “scale agents” or institutions that can facilitate the knowledge transfer to actors operating at a different scale.

4.2. Composition and Structure

The key stakeholders in the COIs included innovators, government agencies, research institutes, NGOs, business, associations, and the public. From this wide spectrum, all interviewees mentioned at least one governmental institution and innovators as the key ingredients. In this context one of the key findings was the COI Triangle, composed by solution provider (innovator), demand side (end user), and finance/funding (funder/financier). Interview participants were asked how their COI could relate to this triangular structure. Interviews confirmed the critical role of value co-creation, with “interdependent, nested, transitional and interconnected” actors [14]. However, a common weakness identified by the interviewees was the lack of involvement from the investor’s side.

There was no common pattern in the creation of the COIs. Some were based on personal connections, relying on informal connections, whereas others reflected on the importance of having an “official or administrative” champion.

In all interviews, transdisciplinarity was seen as a benefit for the community, or even a necessity, because problems to solve had a high level of complexity and uncertainty. In the Dutch COI, only water management experts were involved. However, their skills were still very diverse. In Portugal, where the central issue—fire hazards—demanded technical, governmental, and psychological solutions, having a diverse crowd of community members was crucial for effective problem solving.

4.3. Supply-Side Innovators and Innovations

Another important feature comes from [14], who define the innovation ecosystem as “the evolving set of actors, activities, and artefacts and the institutional including complementary and substitute relations that are important for innovation performance”. In our context the “artefacts” and the “institutional” point to sociotechnical solutions. The “artefacts” provided vary greatly within the COIs, with some working mostly with early-stage innovations with technology readiness levels (TRL) 2–5 and others with solutions already in the market.

Availability of funds for scaling innovations also impacts how COIs evolve. Advanced CoIs claimed to have access to local funding sources (e.g., from public authorities). The less mature COIs claimed to compete for EU funding, which can initially make progress slower. In general, though, where local commitment was secured, progress accelerated.

Innovators in our COIs were mainly “hard” scientists, engineers, modellers, etc., and to a lesser extent “soft” scientists. They comprised entrepreneurs from private companies, R&D departments, and spin outs from public universities, etc. Importantly, a bias towards infrastructural innovations emerged since the project funding for some innovations covered only infrastructure expenses and not personnel costs.

4.4. Problem Owners (Demand Side)

Our COIs were centred around disaster risk reduction and climate change adaptation; therefore, in most cases, the problem owners were public institutions. As public institutions have often existed for a significant amount of time and regularly have traditional hierarchical and non-flexible structures in place, a problem that COIs often had to face was risk aversion from public institutions in a chicken and egg situation. Yet climate adaptation problems already exist. Several COIs mentioned that, when dealing with the public sector, an underlying structural issue is that innovative solutions are often costly and have no

immediate pay off—this therefore makes it difficult to find a public representative who is willing to take the lead in implementing these innovations.

There were also signs that in several COIs that public entities are starting to become more aware of new climate challenges lying ahead and thus are exploring means to be better prepared. Other stakeholders also took part and added value by anticipating/identifying long-term climate change problems, supporting design of socially beneficial solutions, and supporting implementation—through networks to regional council buyers. The COIs illustrate that altering a public institution's practices (for example, by involving public institutions in transdisciplinary collaboration rather than standard transactional relationships between public institutions and other parties) can result in transformative change that can be the basis for new public action in the future.

4.5. Investors, Funders, and Financiers

The few COIs that involved investors reported that investors play a key role in bringing innovations to market. Key challenges identified for investors within the field of disaster risk reduction include responsibility and liability when disasters occur, and uncertainty on the effectiveness of solutions. COIs can help address these issues increasing confidence in the feasibility and potential of the solution. The inclusion of test sites representatives and regional governments in the COI alongside investors is critical here: building on test site results (such as Floor Proof Romania and the Albanian Green Village), regional governments can act as first movers, funding further prototypes or demonstrators through innovative public procurement and thereby helping build investor confidence. A few of the COIs also included the insurance sector, who were seen as a potential investor due to their responsibility for insuring houses or agricultural or other areas.

The selected COIs illustrate the importance of including finance/funders for innovation development. The BRIGAD project effectively acted as a funder, financially supporting 39 selected innovations to increase their TRL level and to create their own business plan. All the innovations increased their level of TRL by at least one level (and one-third increased at least three TRL levels). These conclusions applied to COIs with innovations across the four categories of hazards (droughts, extreme weather, floods, multi-hazards), across 12 different countries. For instance, in the Wildfire COI, there were seven innovations (three in Portugal, one in Spain, one in Italy, two in Albania), ranging from TRL 3 to TRL 7, each addressing different phases of the Integrated Fire Management (IFM) approach that is used for effective forest fire management and risk-informed policymaking [16] (see Appendix C for an explanation on what TRLs are).

4.6. Main Task and Activities

A quantitative survey that was conducted revealed that there were a number of tasks and activities where COIs were very active in terms of the results from a quantitative survey. First, in facilitating the sharing of knowledge and information among innovation-related stakeholders; second, in bringing or generating opportunities for innovation; third, in supporting the co-development of innovation resulting from R&D activities; and finally, in the dissemination and upscaling of ideas. In Table 3, the numbers represent the aggregate number of activities for all COIs for that activity—the higher the number, the more frequent that activity was across all COIs.

Key activities pivoted around the testing and demonstration of innovations supported by the project. Furthermore, workshops, meetings, and other interactions were also organised, with variation across COIs, from the case of the Netherlands, as an informal network, to the case of Albania, which had regular activities focused on the maintenance of the network, achieving a relatively stable structure, with organised innovation meetings, webinars, etc.

Table 3. Innovation activities' quantitative results from COIs (self-evaluation).

Activities Undertaken by COIs	Netherlands	Spain	Albania	Berlin	Venice	Romania	Portugal	Total
Scouting new opportunities	2	3	4	4	2	3	5	23
Creating new business models	2	1	2	3	2	3	2.5	15.5
Bringing innovations to market	2	2	3	3	3	4	3	20
Innovation that results from R&D activities	4		3	5	3	5	4	24
Developing new business models		1						1
New users or combinations of existing technologies	1	2	3	4	3	4	3	20
New ways of interacting with users	4	2	3	4	2	4	4	23
Commercial introduction of a new or significantly improved product or service	4	3	3	4	3	2	3.5	22.5
Non-commercial applications	1	3	3	3	3	3	5	21
Innovations to address social needs	4	2	4	4	3	3	3	23
renewal and enlargement of products, services and markets	4	1	3	4		3	3.5	18.5
development of new methods of production	2	1	5	1	2	4	na	15
establishment of new management systems	3	3	4	4	2	3	3	22
facilitate the sharing of knowledge	4	4	5	5	3	3	5	29
Bringing or generating opportunities	4	4	4	5	4	4	4	29
Incubation and prototype creation	4	1	4	4	3	2	3	21
Dissemination and upscaling of ideas	4	3	4	4	2	4	5	26

In order to further develop the COIs, we identified a number of factors, from having the support of clients adopting innovations, access to grants, and testing facilities, all the way to having real implementation and success stories to “show and tell”, getting the range of stakeholders interested and engaged in the real issues that affect them.

4.7. Learning and Reflections

The very concept of communities of practice, the origin of our specialised climate COIs, emerged from the concept of situated learning [17], i.e., the opportunity to learn together and from each other about real life problems [18]. Lippitz et al [19]. summarise what defines a COI and includes two points related to the learning component: First, a focus on learning and building capabilities to manage innovation and entrepreneurship, rather than seeking specific business, macroeconomic, or social results. Second, an emphasis on sharing and mutual learning among regularly involved participants from diverse organisations, as well as industries. This learning approach is focused more on building trust and relationships and sharing insights, as opposed to more conventional one-way teaching that we see in taught classes.

Considering this approach, there were two separate levels in the learning process produced because of the direct interaction of different actors within the COIs. On the one hand, internal learning produced within each COI was valuable to manage and foster innovation, and on the other hand, mutual learning among COIs with the identification of issues that could be considered to facilitate the potential replication of activities from one COI to another, e.g., analysis of what worked well and what did not. For this replication to be achieved, the differences and commonalities in the context of each COI need to be determined and considered.

In terms of learning across the COIs, leaders commented that it had not really happened in a structured way. Rather, it had emerged from personal contacts; informal communication; or by observing and learning, being inspired by others. However, all COIs saw the potential for inter-COI learning, such as, for example, the Dutch COI commenting “it would be useful to have more insight into the challenges and solutions of others. We only looked at the innovator point of view, while Spain looked more at the clients view”. As discussed earlier, a landscape of practice, where the role of learning carries across COIs in multilevel learning, sharing practices is critical [18].

5. Discussion and Further Research

Having a deep understanding of beneficiaries (i.e., end users or problem owners) and their problems is a fundamental issue in demand-pull innovation and co-creation processes. In line with other literature in COIs, we can confirm that COIs have the characteristics of being emergent, informal, and (up to a point) self-selecting [10]. The COIs analysed in this paper were all conceived and established with the aim of generating solutions for climate adaptation and disaster risk reduction. As the issues affect the whole of society, the problem is often perceived as public and ownership is widely attributed to government agencies. This notion was consistently validated by the COIs studied in this paper. Consequently, public administrations play a central role here not only as problem owners but as “drivers” of innovation. This means public administrations are frequently expected to carry the responsibility to lead or facilitate the procedures and be in the mindset of accepting innovations.

National institutions have the potential to drive innovation through a wider resource availability and their capacity to facilitate interaction among stakeholders. However, the COIs in the case studies often encountered public institutions that did not yet operate within a culture of innovation, tending instead towards established processes, bureaucracy, and risk aversion. In some cases, getting public bodies to participate in the COI gatherings was difficult due to staff limitations and full schedules. Expectedly, when the innovative solutions ideated are costly, highly uncertain, or provide benefits mainly in the long-term, it is difficult to find a public representative who is willing to take the ideas forward. Here,

arenas such as testing facilities for innovations, which sometimes are available through a COI's network, can be a useful asset to encourage the engagement of public administrations. In addition, the COIs provide evidence of the potential barrier of established practices, as well as the potential for new practices to pave the way to future transformational change.

Our analysis indicates that the level of commitment and group cohesion that COIs can achieve are considerably higher than that of other forms of organisation. This stems from the fact that participation in a COI is voluntary, while other formats are often driven by forces that are not so effective in generating a strong sense of ownership and belonging. At the same time, voluntary participation means that the costs of establishing and operating a COI can be kept significantly low. On the other hand, relying on voluntary participation can result in limitations in terms of group size and the speed at which it produces concrete impacts. However, these implications may be offset by the increased chances of uptake that solutions emerging from COIs have if an active involvement of problem owners, solution providers, and financiers is secured. The thematic focus of COIs is one of their key advantages in this respect. If within this thematic focus, the group can concentrate on a specific problem, then it can move extremely fast, as it can quickly centre the attention on the needs of problem owners and identify operable solutions.

COIs are often less formal and certainly less profit-driven than innovation clusters. The value that is created in a COI predominantly lies in the rapid development of intellectual capital. The types of innovations that emerge from a COI are also wider-ranging than those of the latter, commonly including social and socio-technical innovations. These traits fit well with the COIs' voluntary spirit and can make them highly effective at creating new and stronger relationships. This in turn creates a virtuous circle that facilitates openness and trust in the collaboration.

COIs are also more transdisciplinary and less geographically constrained than other formats of collaboration, such as accelerators and innovation clusters. This can make them more dynamic and flexible, and especially suitable in digital settings and/or for generating innovative solutions to complex issues such as climate adaptation. On the other hand, compared to innovation ecosystems, COIs tend to be narrower and less complex in their composition. This has to do with the fact that COIs are thematic, and thus while they include a wide range of stakeholders in their ranks, from the very start, these come together on the basis of a specific issue that they intend to tackle.

COIs are not static but continuously evolving mechanisms that can adapt and react to changes in their environment. This links to the notion that mature COIs, who have reached a good command of a certain problem or set of problems, could do well in turning their attention to new issues, enlarging the range of issues they explore, or exporting the successfully implemented solutions and knowledge to regions who are just starting to experience the same climate impact challenges.

The role of COIs in the future will be to form a multi-level ecosystem of actors that is able to adapt and respond to the climate challenges that will be revealed in the years to come. While it is important that the communities have a local basis and understand the local context, in order to become truly resilient, they will need to network and learn from one another. To accelerate innovation, they will also need to establish narratives of change that are scalable across different local contexts

While our endeavour has been successful in putting the concept of COIs into practice in seven highly diverse cases, there are still many lessons to be learned. This is especially true for the issues of inter-community exchange and the anchoring of COI efforts and initiatives into concrete, impactful action.

In terms of critique of our own learning on the COIs, several important questions remain: First, the limited capacity to draw in the third element of our triangle, the funding and financing. This indicates this must be considered much more *ex ante* to be able to identify the leverage points for their engagement as a key partner for the COIs and their funding capacity to take innovations through the innovation cycle. Second, the sustainability and evolution of our COIs. The scope, scale, and timeline of the COI being

created may need to be considered at the origin of the COI to ensure sustainability. In our case most COIs, most were created spontaneously and evolved at their own pace; however, in hindsight, their sustainability should be a key consideration, both in case these are seen as transient organisations, or in case their evolution could lead to a more formalised structure or official champion or hosting institution. Finally, a way to consider metrics or accountability for success, even if these metrics are defined by the COI members themselves, and, as we learnt, much of the value of the COIs may be intangible assets (such as trust or relations, as well as innovations developed).

In terms of future studies, one area of further research would be to assess the extent that COIs can learn from one another, and how best to manage cross-fertilisation. All COI leaders perceived utility in getting more insight into the challenges being addressed by other COIs, as well as the solutions that were generated. Understanding the distinct angles that different COIs adopted (e.g., placing a closer focus on either the innovators' or the clients' perspective), the methodologies COIs implemented, and the barriers COI encountered were regarded as useful areas to document. Additional research on how to best ensure that these exchanges can take place without becoming overly burdensome or costly, especially given the voluntary basis of COI involvement, would be desirable.

Another relevant matter to study further is how COIs and their leaders can avoid becoming mechanisms that are good at facilitating interaction among stakeholders and triggering conceptual discussions, but fall short in achieving high-impact, concrete adaptation action. This is a constant risk that can be driven by bureaucratic hurdles, lack of funding, and absence of political will from problem owners, amongst others. As new experiences emerge, it will be important to identify patterns and good practices that could be replicated.

6. Conclusions

One of the most important roles for the future that COIs could play in relation to climate change adaptation refers to the importance of creating “niches” in innovation ecosystems. It will be particularly important to create these niches to help transition to more sustainable futures. These niches facilitate or give the opportunity for the different actors involved in COIs to experiment, to cross boundaries between spatial, technological, or normative paradigms. Innovation niches are defined as the spaces that allow actors to experiment and co-create new technologies, practices, and institutions that can support transitions [11], and eventually transform systems. These spaces in which the direction and unfolding of innovation is negotiated takes place amid communities of innovation for climate change adaptation.

A key characteristic of these COIs is that actors can experiment, co-innovate, create, and ultimately enable the collective action of several actors, i.e., our COI triangle. Together they can develop a common identity and a narrative of change that unifies the participating agents. These narratives will help to change the value—laden referent frames, bringing in communal and relational value (social capital). The role of narratives in communities of innovation is to imagine alternative futures and seek to advance societal transformation. Both narrative content and narrative construction play a role in revealing that the future does not only hold “more of the same but that there are indeed ways to reveal the failings of current institutional systems and suggest alternatives” [15]. Each COI leader that was interviewed untangled their own narratives on context-specific transformations that are necessary to become resilient for the future disruptions and uncertainties that climate change will bring. We argue that COIs can help to “transition (and potentially) transform” current systems towards more sustainable futures ones, pushing epistemic boundaries and building on both tacit and explicit knowledge that combine situated learning and practice. Social change is driven by the processes of innovation and vice versa.

The inherent complexity of climate change problems requires well-coordinated trans-disciplinary expertise operating in a context of collaboration, trust, and openness. For at least the past decade, innovation has risen in the EU policy agenda as a key to tackle the region's environmental challenges while revitalising its economy, with an extra new

push under the EU Green deal and new EU Adaptation Strategy. As a result, old and new mechanisms of collaboration are put to the test to foster innovation in climate action. The creation and study of the climate change adaptation and disaster risk reduction COIs has shown that, as the challenges posed by climate change are dynamic and highly place- and context-specific, so should be the mechanisms employed to address them.

National adaptation strategies and disaster resilience plans are instrumental in providing a frame for coherent action and, optimally, the necessary funding for implementation. Nevertheless, the specific environmental, economic, and social challenges triggered or exacerbated by climate change often take distinct forms at lower geographical scales, and thus climate adaptation remains a local or regional process. At the same time, climate adaptation has an inherent social component that requires the consideration of the needs and priorities of all affected parties. COIs exhibit great potential as mechanisms to facilitate wide stakeholder involvement and knowledge transfer between actors operating at a different scale. COIs have the means to generate the trust and openness necessary to provide common spaces for fruitful exchange and create niches for narratives of change for climate change adaptation, using risk as an opportunity to “innovate” different futures. This should yield solutions that are more effective, technically and economically feasible, socially acceptable, environmentally sustainable, and future oriented.

As Margaret J. Wheatley [20] stated, “There is no power for change greater than a community discovering what it cares about”.

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Appendix A

Summary of Key Terms

Communities of Innovation¹ are one of a number of forms of organisation to support the development of innovations and their implementation, including innovation ecosystems, **living labs**, and clusters of innovation. In this section, we define each of these forms of organisation, and identify how Communities of Innovation differ and add to these other organisational innovation typologies.

Summary of Key Terms

Innovation clusters² have a formal structure and are often supported by a public body and are geared to specific production chains. An innovation cluster is composed by a series of regional actors, with different modes of creation, financing, and operation, depending on the country and the given region. Innovation has proven to perform better in clusters and has become a popular instrument for innovation policy activities at regional scale. Clusters are economic networks of firms, knowledge production agents, bridging institutions and customers, that are linked to each other in a value-adding production chain. The focus is on the linkages and interdependence between actors in the network of production when generating products and services and creating innovations. COI's meanwhile are less formal (or formalised) and are less geographically constrained, in the sense that COIs can focus on a local scale, a regional, national or international scale. This can make COIs more dynamic and flexible at a lower organizational and resource cost.

A living lab³ is a network that integrates both user-centred research and open innovation. Following the open innovation approach Open innovation is “the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively.” There are two facets to open innovation. One is the “outside in” aspect, where external ideas and technologies are brought into the firm’s own innovation process. This is the most commonly recognized feature of open innovation. The other, less commonly recognized aspect is the “inside out” part, where un- and under-utilized ideas and technologies in the firm can go outside to be incorporated into others’ **innovation processes**⁴. It means that, for example, a company can use external resources and in turn make available their own innovations to other organizations. The use of living labs. A good example is the Massachusetts Institute of Technology (MIT) with its Media Lab first explored the concept of living lab, and now promotes research and innovation through different living labs, like the City Science project in Andorra³, where the MIT Media Lab’s City Science research group, the University of Andorra, and national and international companies are collaborating in order to bring an innovative ecosystem into the capital of Andorra, engaging local stakeholders on how to improve urban development and planning. It has emerged as a novel form of creating competences and competitive advantage. Open innovation builds on intense co-development with users and the result is expected to better solve customers’ needs and wants. Therefore, users are innovators, co-designers, co-producers, and entrepreneurs regarding new products and services. Compared to COIs, Living Labs involve a broader range of end-users and begin earlier in the ideation phase (starting with needs assessment), and focus narrowly on a specific geographic area. COIs, in comparison, have a more defined innovation objective and narrower scope of participants (end users with specific problems, and with funders and financiers as key actors) what we call the COI triangle described earlier.

An innovation ecosystem⁵ is a group of actors who are interconnected and interdependent and set for the co-creation of value. The term ‘innovation ecosystem’ originally stems from ‘business ecosystem’ but has increasingly come to replace the concept within academic literature. One of the core differences is that a business ecosystem refers to value capture whereas an innovation ecosystem value creation predominates over value capture. Both innovation and business ecosystems comprise two distinct economies, the research economy, which is driven by fundamental research and the commercial economy which is **driven by the marketplace**⁶. In the same way that natural ecosystems are based on a complex set of relationships among the living resources and habitats that maintain a balanced state, an innovation ecosystem features complex relationships that are formed between actors or entities whose goal is to enable technology development and innovation, in our case the creation and support of an innovation ecosystem around climate change adaptation and DRR. What makes innovation ecosystems different to the other concepts is the dynamism and complexity of the relationship between its different components and the breadth of focus: it goes beyond a limited number of actors to include the wider context within which innovation occurs, including government policy, broad economic sectors, and numerous SME and large companies, universities, and other actors who affect innovation.

¹ Jackson, D.J. (2011) What is an Innovation Ecosystem? National Science Foundation, Arlington, VA. ² Muro, M. and Katz, B. (2010). The New ‘Cluster Moment’: How Regional Innovation Clusters can Foster the Next Economy. The Brookings Institution. ³ Westerlund, M. and Leminen, S. (2011). Managing the Challenges of Becoming an Open Innovation Company: Experiences from Living Labs. Technology Innovation Management Review, October 2011. Available at: <http://www.timreview.ca/> (accessed on 2 May 2021). ⁴ Chesbrough, H. (2011). Everything you need to know about open innovation. Forbes. 21 March. Retrieved from: <https://www.forbes.com/sites/henrychesbrough/2011/03/21/everything-you-need-to-know-about-open-innovation/#4f5bc2ff75f4> (accessed on 2 May 2021). ⁵ De Vasconcelos Gomes, L.A., Facin, A.L.F., Salerno, M.S. and Ikenami, R.K. (2018). Unpacking the innovation ecosystem construct: Evolution, gaps and trends. Technological Forecasting and Social Change, 136, pp. 30–48. ⁶ Oh, D.S., Phillips, F., Park, S. and Lee, E. (2016). Innovation ecosystems: A critical examination. *Technovation*, 54, 1–6.

Appendix B

Community of innovation leaders interviewed.

COI	COI Lead	Type of Organisation
COI Albania	AKPT	Public agency
COI VP Delta	HKV	Company
COI Venice	THETIS	Company
COI Romania	NAAR	National agency
COI Cartagena	FutureWater	Company
COI Wildfires	ISA	University
COI Berlin	Ecologic	Research think tank

Appendix C

TECHNOLOGY READINESS LEVELS (SOURCE: EU H2020 TRL LEVELS)

- TRL 1—basic principles observed
- TRL 2—technology concept formulated
- TRL 3—experimental proof of concept
- TRL 4—technology validated in lab
- TRL 5—technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 6—technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 7—system prototype demonstration in operational environment
- TRL 8—system complete and qualified
- TRL 9—actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies, or in space)

References

1. Mazzucato, M. Mission-Oriented Research & Innovation in the European Union. A Problem-Solving Approach to Fuel Innovation-Led Growth. European Commission. 2018. Available online: https://ec.europa.eu/info/sites/default/files/mazzucato_report_2018.pdf (accessed on 1 May 2021).
2. IPCC. Special Report on Global Warming of 1.5 °C. 2018. Available online: https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_Low_Res.pdf (accessed on 1 May 2021).
3. European Commission. *A Renewed European Agenda for Research and Innovation-Europe's Chance to Shape Its Future*; European Commission: Brussels, Belgium, 2018.
4. Marée, M.; Mertens, S. The Limits of Economic Value in Measuring the Performance of Social Innovation. In *Social Innovation*; Nicholls, A., Murdock, A., Eds.; Palgrave Macmillan: London, UK, 2012.
5. Montoro-Sanchez, A.; Ortiz-de-Urbina-Criado, M.; Mora-Valentín, E.M. Effects of Knowledge spillovers on Innovation and Collaboration in Science and Technology Parks. *J. Knowl. Manag.* **2011**, *15*. [CrossRef]
6. Coakes, E.; Smith, P. Developing communities of innovation by identifying innovation champions. *Int. J. Knowl. Organ. Learn. Manag.* **2007**, *14*, 74–85. [CrossRef]
7. Elia, G.; Petti, C.; Sarcina, A. Promoting communities of innovation: Do industrial policies matter? *Int. J. Knowl.-Based Dev.* **2016**, *7*, 207–224. [CrossRef]
8. Gherardi, S. *How to Conduct a Practice-Based Study: Problems and Methods*, 2nd ed.; Edward Elgar Publishing: Northampton, MA, USA, 2019; ISBN 9781788973557.
9. Lim, M.; Ong, B. Communities of innovation. *Int. J. Innov. Sci.* **2019**, *11*, 402–418. [CrossRef]
10. Pattinson, S.; Preece, D.; Dawson, P. In search of innovative capabilities of communities of practice: A systematic review and typology for future research. *Manag. Learn.* **2016**, *47*, 506–524. [CrossRef]
11. Pigford, A.A.E.; Hickey, G.M.; Klerkx, L. Beyond agricultural innovation systems? Exploring an agricultural innovation ecosystems approach for niche design and development in sustainability transitions. *Agric. Syst.* **2018**, *164*, 116–121. [CrossRef]
12. Wenger-Trayner, E. *Introduction to Communities of Practice. A Brief Overview of the Concept and Its Uses*. 2015. Available online: <https://wenger-trayner.com/wp-content/uploads/2015/04/07-Brief-introduction-to-communities-of-practice.pdf>.
13. Edison, H.; Ali, N.B.; Torkar, R. Towards innovation measurement in the software industry. *J. Syst. Softw.* **2013**, *86*, 1390–1407. [CrossRef]
14. Granstrand, O.; Holgersson, M. Innovation ecosystems: A conceptual review and a new definition. *Technovation* **2020**, 90–91. [CrossRef]
15. Wittmayer, J.M.; Backhaus, J.; Avelino, F.; Pel, B.; Strasser, T.; Kunze, I.; Zuijderwijk, L. Narratives of change: How social innovation initiatives construct societal transformation. *Futures* **2019**, *112*, 102433. [CrossRef]

16. Colaço, C.; Dias, S.; López Gunn, E. News from the Horizon 2020 project BRIGAD's Wildfires Community of Innovation (CoI). In *DRMKC BULLETIN #19*; European Commission: Brussels, Belgium, 2020; pp. 23–24.
17. Lave, J.; Wenger, E. *Situated Learning: Legitimate Peripheral Participation (Learning in Doing: Social, Cognitive and Computational Perspectives)*; Cambridge University Press: Cambridge, UK, 1991.
18. Pyrko, I.; Dörfler, V.; Eden, C. Communities of practice in landscapes of practice. *Manag. Learn.* **2019**, *50*, 482–499. [[CrossRef](#)]
19. Lippitz, M.; Wolcott, R.; Andersen, J.B. *Innovation Communities: Trust, Mutual Learning and Action*; Nordic innovation: Oslo, Norway, 2012.
20. Wheatly, M. *Turning to One Another: Simple Conversations to Restore Hope to the Future*; Berrett-Koehler Publishers: San Francisco, CA, USA, 2002.