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The Spaces of Resilience: Learning and Adaptation

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Abstract

"To succeed in the modern economy you need technical and adaptive skills. Technical skills and specialized knowledge makes you a more efficient and productive worker, but it can lock you in to a part of the division of labor that can disappear over night in the winds of creative destruction that increasingly sweep across the economy. Across both natural and human systems, processes that increase the efficient production of wealth and stored energy undermine resilience" (Swanstrom, 2008: 6-7). In fact, at a time of crisis it seems that the territories are even more vulnerable and fragile: emerging social issues (like new poverty), new needs, frayed social fabrics and lack of social networks. This syndrome of weakness can be remedied only if the collective intelligence of an area tries to develop development policies for education and culture of legality, stimulating 'communities of practices' and investing in intangible factors of development. A successful economy creates tight connections between the industry, society and the government (e.g. Triple Helix Model) but these same connections can make difficult to shift public policies and redeploy assets in the face of a crisis (Safford 2004). Similarly, lean companies with just-on-time production and global supply chains, may be highly efficient but they are vulnerable to disruptions (Sheffi, 2007).

This paper analyzes the mechanisms of adaptation and self-organization to promote resilience; particularly, after describing the relationship between risk, resilience and sustainability, we have focused on the ecological model of resilience that reconciles the contradiction mentioned above through the idea of panarchy that

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captures the "evolutionary nature of adaptive cycles that are nested one within each other across space and time" (Holling, 2001: 396).

Keywords: resilience, learning, sustainable development.

1. Risk, Vulnerability and Resilience: Conceptual Specifications

The risk society is the form that the current phase of advanced modernity are taking, in which the development of industrialization produces wealth and social risks (Beck 2000: 25). In this context it is not easy to disentangle the interconnections issues about what is the meaning of risk: In this way, rather than a vision and a shared knowledge, debates, indecision and inanity born. The same Luhmann, who cares to find a definition of the concept of risk more or less reliable, informs us that when searching for definitions of risk, "you find yourself immediately in the dense fog" (Luhmann, 1996: 15).

Beck, meanwhile, makes the distinction between risk and catastrophe. "Risk is not synonymous with catastrophe. Risk means the anticipation of catastrophe. [...] The risk category thus refers to the controversial reality of possibility [...] When the risks become reality [...] turn into disasters. Risks are always future events that may lie ahead, that threaten us. But since this threat determines our expectations, occupies our minds and guide our actions, become a political force that changes the world" (Beck 2008: 8).

Another distinction between risk and uncertainty; for some scholars (Bauman, 1999 and 2008), the latter is the real critical point from which to start the analysis of the situation, because the risk is conceived as the space between the prediction that a certain fact happen and its actual occurrence (Vespasiano, 2011: 42-43). On the basis of these statements, it can be noted that the systemic approach to the study of risk begins with a definition of risk as an expression of uncertainty in the system-environment relationship. It therefore provides the probability of occurrence of a negative event, the identification of individual components that are exposed to this event and the analysis of the functional relationships (Walker, 2007).

For these reasons, we say that each area is subjected to a certain degree of vulnerability. It is possible to identify two characters of the vulnerability, which together determine the probability of a system to suffer damage after a negative event: a "structural" vulnerability, referring to the features of the organization of the system; a "systemic" vulnerability referring to the relational features and to those ones that determine the opening of the system to the external environment. And it is possible to identify two components

the ability to react: "resilience", the ability to cope with the effect of perturbing action produced by a negative event, which depends on the adaptation and regeneration capacities of the system; the "resistance", the attitude of the system to equability (Graziano, 2012: 3). The concepts of resistance and structural vulnerability are complementary, but also those of systemic vulnerability and resilience (Fortune, Peters, 1995; Galderisi, Ceudech, 2003).

The conceptual clarification above analysis is needed to understand the development of hybrid approaches to research that on the one hand, fueling confusion in the interpretation of these concepts, on the other hand promote the development of scientific debate around research methodologies, analysis and measurement of these phenomena. The plot between different disciplines (ecology, sociology, economics and urbanism) characterizes the literature on socioecological systems. The development of the research has been expanded thanks to the emergence of a scientific consortium, *Resilience Alliance*, whose purpose is to investigate the dynamics of ecological and social systems, the relationship between adaptive capacities and sustainability, the role of policies at regional and meta-regional levels (Graziano, 2012: 6).

Eakin and Luers identify three different approaches to the study of risk and vulnerability: that of *risk mitigation*, in which the vulnerability is identified in the assessment of the potential harm, the *research in the political-economic and political-ecological*, characterized by an idea of vulnerability as a condition that depends on the accessibility and fairness in the distribution of opportunities and resources, the *literature on the topic of ecological resilience*, in which risk and vulnerability are interpreted as dynamic properties of a system, the size of which are in the social and ecological constantly evolving (Ibidem: 4-5).

Table 1 summarizes the main features of the three approaches considered, with research methodologies and analysis tools.

The ecological idea of resilience stretches back twenty-five years ago to a seminal article by C. S. Holling (1973). Ecological resilience differs from engineering resilience. Engineering resilience is the ability of a system to return to equilibrium after a disturbance, like a thermostat that returns the temperature in a house back to 70 degrees after an ice storm. The ecological concept of resilience is based on multiple equilibria. This means that ecosystems are able to respond to perturbations by changing their structure and functioning to a new system. The idea of multiple equilibria fits metropolitan areas better because regions must reinvent themselves in the face of challenges. When industrial jobs disappear, regions cannot just reinvest in the manufacturing sector in the hope of recreating a prosperous economy based on heavy industry. Instead they must reinvent themselves to find a new profitable niche in the global economy (Swanstrom, 2008: 5).

TABLE 1. Approaches to the study of risk

Line of research	Focus	Analysis unit	Methodologies and analysis tools	Research experiences
Mitigation of risks	Identification of disturbing events. Estimate of the expected economic and social impacts	Nation, region	Construction of indices. Analysis of the spatial distribution of the components of risk	Intergovernamental Panel on Climate Ch'ange (2001) Cutter, Finch (2007 Peterson (2002) O' Brien, Leichenko, Kelkar, Venema, Aandahl (2004)
Economic and ecological policies	Analysis of the social, economic, political, cultural and environmental features that explain the risk exposure and the ability to cope to the unexpected impacts	Nation, region	Construction of indices. Participatory methods. Case Study. CGE models	Briguglio, Cordina, Farrugia, Vella (2008). Blaike, Cannon, Davis, Wisner (1994). Naudè, McGillivray Stephaniè (2008). Pelling (1999). Rose, Liao (2005)
Ecological resilience	Analysis of the evolutionary trajectories, autopoiesis of social systems. Identification of systemic thresholds and load capacity	Eco-systemic region	Qualitative and quantitative ecosystem models. Methods of social simulation. Multi-agent models	Holling (1973). Carpenter, Broke, Hanson (1999). Carpenter, Walker, Anderies (2001). Valazquez-Leon (2003). Adger (1999). Martin (2011). Pendall, Foster, Cowell (2010). Simmie, Martin (2010)

In this sense, resilience has three defining characteristics:

• the amount of change a system can undergo (and, therefore, the amount of stress it can sustain) and still retain the same controls on function and structure (still be in the same configuration - within the same domain of attraction);

• the degree to which the system is capable of self-organization. The resilience of a region is a community's ability to continue its development by organizing itself against external shocks that may increase its vulnerability and even its existence. When managers control certain variables in a system, they create inter-variable feedbacks that would not be there without their intervention. The more "self-organizing" the system, the fewer feedbacks need to be introduced by managers. Furthermore, if the system is strongly self-organizing, those feedbacks that do need to be built in by managers are not "delicate" or "sensitive," in that there can be significant error in the feedback induced by the manager without the system deviating from the desired behavior;

• the degree to which the system expresses capacity for learning and adaptation (Walker, 2003: 12).

Resilience, therefore, is the potential of a system to remain in a particular configuration and to maintain its feedbacks and functions, and involves the ability of the system to reorganize following disturbance driven change (according to Resilience Alliance's definition, resilience is the ability to absorb disturbances, to be changed and then to re-organize and still have the same identity (retain the same basic structure and ways of functioning). It includes the ability to learn from the disturbance).

In an operational sense, resilience needs to be considered in a specific context. As discussed by Carpenter *et al.* (2001), it requires defining the resilience *of* what *to* what?

Resilience is not necessarily desirable. System configurations that decrease social welfare, such as polluted water supplies or dictatorships, can be highly resistant to change. Some (social) systems may be resistant, yet not resilient (i.e., they do not allow for self-organization and learning), but some undesired ecological configurations may indeed be both resistant and resilient.

Ecosystem approach the conceptualization of vulnerability uses a definition opposite to that of resiliency (Fortune, Peters, 1995). A vulnerable ecosystem is a system that has lost its resilience, becoming exposed to the risk of a negative impact that previously could be absorbed. In a vulnerable system even small perturbations can qualitatively alter the state and the development dramatically, causing results devastating. In a resilient system, the change has the potential to create opportunities and development: not only the system is able to recover a situation similar or equal to the previous one but, through the processes learning, is able to introduce variations that may constitute important innovations (Graziano, 2012: 9).

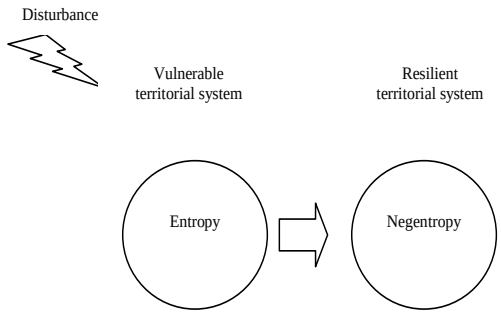
Sustainability, in contrast, is an overarching goal that generally includes assumptions or preferences about which system configurations are desirable. Building resilience of a desired system configuration requires enhancing the structures and processes (social, ecological, economic) that enable it to reorganize following a disturbance. It also requires reducing those that tend to undermine it (Walker *et al.*, 2002: 5 ss.).

2. Relationship between Risk, Resilience and Sustainability

The increase in the levels of self-organization and complexity can lead a complex system to improve its ability to respond to external stimuli (Bertuglia, Staricco, 2000). The concepts of risk, vulnerability and resilience can be explained by a spatial representation of the territory as a complex system. The territory is an open system, whose components are closely intertwined; here is characterized by the presence of energy flows and information and the

existence of feedback loops that cause non-linear processes (Martin, Sunley, 2007). The territory, as a complex system, in front of an event that generates interruption and uncertainty and an increase in entropy, can oppose a variation of opposite sign (resilience), increasing their levels of organization, by means of actions that modify the relationships between its elements (Figure 1).

FIGURE 1 - Resilience and vulnerability of the territorial system



Resilience and vulnerability are both shaped by global and local economic forces. Yet the ability to promote resilience goals within environmental policy is dependent on the ability to frame sustainability questions in these terms and the 'purchase' of them compared to those of free trade, economic choice, or growth. Economic growth is not inherently desirable or undesirable in itself – it is a means to an end. The presently observed uneven patterns of economic growth have negative consequences for the resilience of both human and ecological systems (Adger, 2003: 2). Sustainable development is defined as a set of necessary constraints in the areas of efficiency, equity and resilience of social and natural systems. This is novel in its emphasis on social resilience which captures many aspects of the institutional architecture required for sustainability. Social resilience can be observed through proxy measures associated with property rights and access to resources, through demographic changes and other measures (*ibidem*, 1997: 1)

It is now commonly asserted that sustainable development is development which does not jeopardise future well-being through reduction of the capacity of the environment. The central aspects of such definitions appear to be their focus on the environmental basis for human activity and the temporal dimensions of development and well-being. In particular the long

term aspects of sustainable development, equity to future resource users, is often overemphasised, it is argued, to the detriment of present day equity considerations (Beckerman, 1992).

Equally contentious is the role of natural systems within the 'standard' definition of sustainable development, particularly since resources exhibit widely different characteristics. Renewable resources require different treatment to non-renewable resources, while there is no single rule for the sustainable utilization of the functions of resources and ecosystems, for example in terms of their assimilative capacity as sinks for the by-products of economic activity.

In attempting to incorporate these diverse aspects of human environment interactions, an alternative definition of sustainable development can incorporate these issues into a set of necessary criteria for sustainable development. These criteria are centered on efficiency, equity and social and ecological resilience. A summary of an approach to sustainable development which attempts to capture the diversity of approaches is outlined in Table 2. This shows that such an approach results in multiple decision criteria, one of the reasons which makes sustainable development indistinct, but also why the concept itself is so popular but yet highly politicized and inherently 'slippery' (O'Riordan, 1988).

TABLE 2. Economic perspectives on modelling sustainable development

Criteria for sustainable development	Economic interpretation	Measured through:
Efficiency	Present economic welfare maintained and maximised	max [Benefits (B) - Costs (C)]
Equity	Welfare non-declining over time (inter-generational equity) Extremes in equity rules: (i) Resource allocation increasing total welfare (Pareto) (ii) Resource allocation benefiting poorest (Rawlsian)	max [ai . (Bi - Ci)] where ai = distributive weight for stakeholder group
Ecosystem and social resilience	Maximise ability to withstand shocks and uncertain impacts of change	*Ecological resilience* proxies of diversity and functional integrity. *Social resilience* proxies of institutional change, property rights, and demographic change.

This conceptual framework for sustainable development, as set out in Table 1, is one of many ways by which these necessary criteria can be developed. But almost all definitions incorporate these elements to some extent. To give one example, Common (1995: 55) states that: 'the sustainability problem can be stated as that of managing human affairs to address the problems of poverty and inequality while also minimizing threats to ecological sustainability'.

Efficiency in resource use simply means maximizing the economic welfare or well-being derived from the use of finite resources (see Pearce *et al.*, 1990). Resilience incorporates the ability both of social and ecological systems to withstand external shocks and stresses. For ecological systems, resilience may be indicated by the disturbance and speed of return to an equilibrium position.

This indicator is relevant only if the ecological system is assumed to be in equilibrium, and alternatively resilience can be indicated by the amount of disturbance which can be absorbed before a system undergoes threshold non marginal changes to some other state (Holling *et al.*, 1995). In social terms, the resilience of both individuals and communities is a much less well defined concept, since social resilience is only perceived of as a necessary condition for sustainable development when those individuals and communities are linked directly to a resource system where ecological resilience in itself is important.

Sustainability, the promotion of resilience, and the avoidance of vulnerability are directly related to equity, autonomy, and freedom, arising from the entitlement and access to resources and to security. Thus, resilience and justice promote sustainability. They are both observed in and promoted through diversity in both social and environmental systems, and in diverse knowledge systems and ways of looking at the world. Justice in resilience needs to account for the outcomes of resource allocations and policy decisions – how the beneficial and adverse effects of human action are distributed across society. This distributive justice has formed the primary focus of the environmental justice social movements around the world. These movements seek to redress, through law or other means, the inequity in who suffers from localized environmental pollution or inequitable access to land and other resources.

Justice is also made up of fairness in representation - how can societies build the capacity to adapt when vulnerable groups are marginalized and excluded from decisions? Justice is also about fairness in procedures and institutions, recognition of difference, and participation in decision-making (Adger, 2003: 3).

The "syndrome of the weakness" (due to the crisis time, where the territories are even more vulnerable and fragile: emerging social issues, made of new poverty, new needs, a frayed social fabric and lack of social networks) can be remedied only if the collective intelligence of an area tries to activate development policies for education and culture of legality, stimulating communities practices and investing in intangible factors of development (such as construction and socialization of new knowledge, social capital, good practices of a territorial intelligence).

To do this, a different model of citizenship is necessary, which provides the broadest participation of citizens in the decision making processes of governance. This new paradigm, that sees social cohesion as a premise and not as a result of the development, should ensure good governance and therefore the sustainable human development (Martini, 2012).

For these reasons, as an example, ecologists have applied the concept of resilience not just to biological systems but also to the socio-eco-systems, or the interaction of human and natural systems. The basic idea is not just that humans need to understand the emergent systems of resilience in nature and make policies that take into account complex feedback effects. Instead, the human system of ecological management is modeled on the same type of processes that bring order in nature. Applying the framework of ecological resilience to human institutions and governance processes generates paths to greater understanding (Swanstrom, 2008: 6).

3. Mechanisms of Adaptation and Self-Organization to Promote Resilience

The structure of a complex system is based on its spatial and temporal components, whose mutual relations express its organization. It is an open system: and according to the second law of thermodynamics, it can record a change in entropy of negative sign, which can lead to the development towards states of greater heterogeneity and complexity (Bertalanffy, 1950).

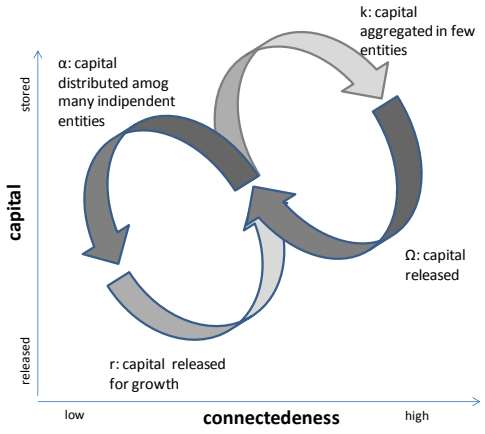
It is characterized by the presence of "leverage points", that are points in which a disturbance can have an amplified impact within of the whole system (leverage), due to the effect of feedback circuits. The ability to produce emergent structures keeps the system far from equilibrium (low entropy), in dynamic conditions, which lead to an increase of order and self-organization. The complex systems have a behaviour oriented towards a point of equilibrium (goal- seeking). Each time the system passes the point of balance produces an error called "dynamic error" which then reacts (Graziano, 2012: 7).

Making mistakes the system learn to anticipate them, thus reducing the uncertainty related to the an exogenous event. This strategy is called "error-controlled regulation" and is the basis of the mechanisms of adaptation and learning. The behaviours of system can be explained by the mechanisms of adaptation and self-organization, which characterize biological systems such as the socio-economic systems (Krugman, 1996).

Reflection on these issues is important because all systems, are never static, and they tend to move through four, recurring phases, known as an adaptive cycle. Generally, the pattern of change is a sequence from a rapid growth phase through to a conservation phase in which resources are increasingly unavailable, locked up in existing structures, followed by a release phase that quickly moves into a phase of reorganization, and thence into another growth phase. However, multiple possible transitions among the four phases are possible and the pattern may not reflect a cycle. The growth and conservation phases together constitute a relatively long developmental period with fairly predictable, constrained dynamics; the release and reorganization phases constitute a rapid, chaotic period during which capitals (natural, human, social, built and financial) tend to be lost and novelty can succeed (see Resilience Alliance's website). The original metaphor of the adaptive cycle that alternates between long periods of aggregation and transformation of resources and shorter periods that create opportunities for innovation, is proposed as a fundamental unit for understanding complex systems from cells to ecosystems to societies and portrayed it as a figure of *8* in two dimensions - increasing connectivity, and increasing capital (Figure 2). The adaptive cycle exhibits two major phases (or transitions). The first, often referred to as the foreloop, from *r* to *k*, is the slow, incremental phase of growth and accumulation. The second, referred to as the backloop, from Ω to α, is the rapid phase of reorganization leading to renewal. During the slow sequence from exploitation to conservation, connectedness and stability increase and a capital of nutrients and biomass (in ecosystems) is slowly accumulated and sequestered. Competitive processes lead to a few species becoming dominant, with diversity retained in residual pockets preserved in a patchy landscape. While the accumulated capital is sequestered for the growing, maturing ecosystem, it also represents a gradual increase in the potential for other kinds of ecosystems and futures. For an economic or social system, the accumulating potential could as well be from the skills, networks of human relationships, and mutual trust that are incrementally developed and tested during the progression from *r* to *k*. Those also represent a potential developed and used in one setting, that could be available in transformed ones. Adaptive cycles are nested in a hierarchy across time and space which helps explain how adaptive systems can, for brief moments, generate novel recombinations that

are tested during longer periods of capital accumulation and storage. These windows of experimentation open briefly, but the results do not trigger cascading instabilities of the whole because of the stabilizing nature of nested hierarchies. In essence, larger and slower components of the hierarchy provide the memory of the past and of the distant to allow recovery of smaller and faster adaptive cycles. A nest hierarchy of adaptive cycles represents a panarchy (see *Resilience Alliance*'s website).

Figure 2. The adaptive cycle - in two dimensions, capital and connectedness, depicted as a figure 8 pattern of dynamics.



The tension between efficiency and innovation, tight connections and freedom to experiment, is also reconciled by being situated at different scales. Basically, the slower, longer term processes operate at larger scales and the faster, short-term processes operate at smaller scales. Usually, the larger scales processes dominate and shape the outcomes of the smaller processes. Thus, for example, climate, geomorphology, and large plants and species dominate over finer grained biochemical processes. But at times that require rapid innovation and change, the lower levels can exercise a "revolt" function, reacting back on the higher levels and changing their structure and function. A resilient system is one where these smaller scale processes are able to deal with the stressor without having to reorganize the larger scale structures.

In the case of regions, markets correspond to the faster, more localized parts of the system that are constantly adjusting to change. Local governments represent an intermediate level while the central government and larger culture represent the larger structures that adapt more slowly. A resilient region would be one in which markets and local political structures continually adapt to changing environmental conditions and only when these processes fail, often due to misguided intervention by higher level authorities which stifle their ability to innovate, is the system forced to alter the big structures (Swanstrom, 2008: 9).

4. Conclusion

The concept of resilience is analytically useful but difficult to handle in complex socio-cultural, historically embedded settings.

The issues raised are grand challenges in the evolution of social and environmental governance. Resilience means moving away from simple limits on environmental resource use towards active promotion of dynamic evolutionary processes (Adger, 2003: 3).

Resilience must be understood as a process that takes place in three sectors: private, public, and civil society. Each of these has a characteristic mode for promoting adaptation to challenges, as well as characteristic failures or rigidities. Regional resilience is most effective when each sector operates according to its own principals and is not contaminated by the processes of the other sector. In other words, resilient regional governance is not a holistic process or system, as is suggested by ecological theory, but requires maintaining borders between spheres of resilience (Swanstrom, 2008: 20 ss.):

1. Civic (Nonprofit) Sector: Critical of both markets and governments, ecological theory places civic networks and consensus decision making at the center of resilience. The basic idea is that a diversity of stakeholders can devise innovative solutions that transcend the limits of self-interest. Innovative win-win solutions are possible if stakeholders collaborate.

2. Private Markets: If civil society represents an intermediate level in speed and flexibility, then private markets are clearly the fastest and most rapidly innovative level of resilience. Properly functioning private markets are highly resilient because they motivate decision makers to respond quickly to changing technology and consumer preferences.

3. Public Sector: The public sector represents the broadest scale and the slowest moving parts of resilient systems. Competitive party processes enable democracies to innovate in the face of challenges. When control over the

government changes parties, the opportunity exists to transform the rules that govern resilience.

In conclusion, each of the three sectors is needed to maximize resilience. The private sector maximizes the resilience of individuals, the civic sector of communities, and the public sector of the society as a whole. Without a balance between the three sectors, controlled ultimately by a central authority, society will either become rigid or innovation at one level will undermine resilience at other levels.

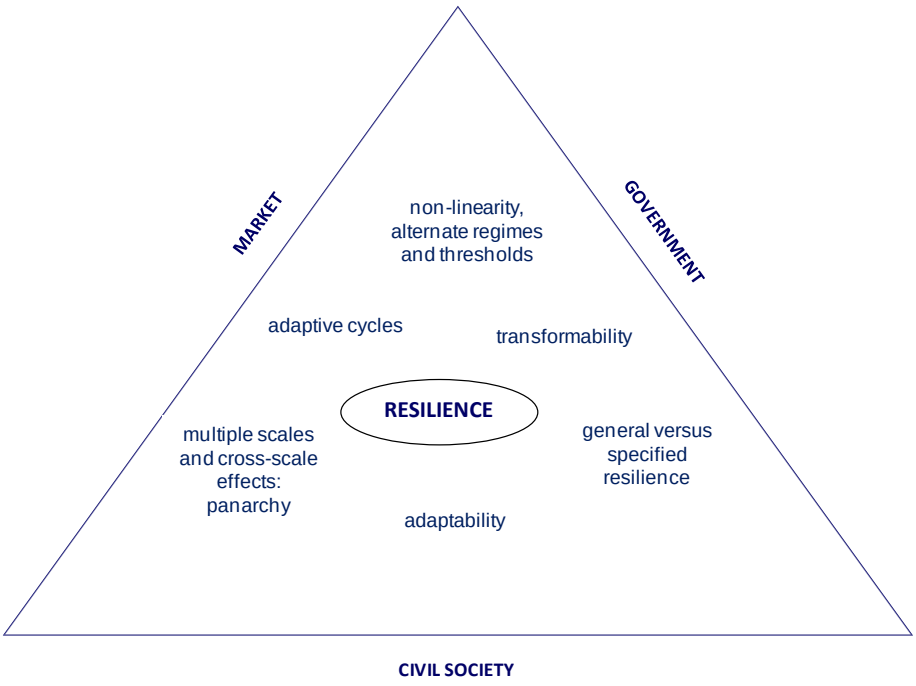
Inside this paradigm, the basic concepts underpinning a resilience approach to policy and management are (see Resilience Alliance's website) (Figure 3):

1. *non-linearity*, *alternate regimes and thresholds* (because of non-linear dynamics, many systems can exist in what are called alternate stable states. The term "states" is often used loosely and can be confusing, so we need to define it. The state of a system at any time is defined by the values (amounts) of the variables that constitute the system. Some configurations are desirable from a human perspective, and others are undesirable. Each configuration is actually a set of system states that has the same essential structure and function - and such a configuration (same structure and function) is termed a system "regime");
2. *adaptive cycles* (generally, the pattern of change is a sequence from a rapid growth phase through to a conservation phase in which resources are increasingly unavailable, locked up in existing structures, followed by a release phase that quickly moves into a phase of reorganization, and thence into another growth phase);
3. *multiple scales and cross-scale effects – panarchy* (no system can be understood or managed by focusing on it at a single scale. All systems exist and function at multiple scales of space, time and social organization, and the interactions across scales are fundamentally important in determining the dynamics of the system at any particular focal scale. This interacting set of hierarchically structured scales has been termed as panarchy);
4. *adaptability* (it is the capacity of a system to manage resilience in relation to alternate regimes. It involves either or both of two abilities: i) the ability to determine the trajectory of the system state; ii) the ability to alter the shape of the basins, that is move the positions of thresholds or make the system more or less resistant to perturbation);
5. *transformability* (in cases where a system is already in an undesirable regime and efforts to get it back into a desirable regime are no longer possible, one option for resolving the predicament is transformation

to a different kind of system - new variables, new ways of making a living, different scales - a different panarchy);

6. *general vs specified resilience* (we can think about "specified" resilience as the resilience *of what*, *to what*. This is what we are mostly concerned about - the resilience of some aspect of a system to some defined shocks. However, efforts to increase resilience of some aspect of a system regime to a specified set of disturbances can unwittingly reduce the resilience of other aspects of that system to other, non-specified (perhaps novel) disturbances).

Figure 3. The spaces and the basic concept of a regional resilience



Source: author's calculation by Resilience Alliance and Swanstrom 2008: 20 ss

A resilient of a region is not just economically successful but maintains economic success over the long term in face of the inevitable adaptation required by changes in international competition, shifts in consumer demand and other such 'shocks' to the system. As we have suggested, the success of a

region can be measured by current and past economic growth, employment rates, standards of living and quality of life. The difficulty is in judging, at any point of time, whether such success will be maintained in the future and in particular whether the region will prove resilient in the face of economic recession or other challenges. One way to make this difficult prediction is to examine which regions have proved resilient in the past and to learn lessons from how such resilience was achieved. In this perspective, see resilience in terms of an ability, following an economic shock, to return to the previous equilibrium growth path is wrong.

The idea of an equilibrium growth path is, in itself, of questionable validity or usefulness, but certainly once any such path has been disrupted, the idea that it is still there in theory, waiting to be rediscovered, is decidedly unhelpful. Slightly more realistic is the idea of multiple equilibria, whereby if the previous growth path disappears for whatever reason, there may be one or more alternative growth paths that the region may achieve through industrial restructuring and repositioning. But even here, while such multiple equilibria models might be useful for modeling purposes, it is unlikely that the real world bears much resemblance to such a story. Instead, the concepts of adjustment and adaptation are generally regarded as more useful in analyzing regional resilience. For an economically successful region, the likelihood of such success being sustained over the long term will depend crucially on its ability to adapt to changing circumstances over time and to adjust to external shocks as and when these occur.

The question then becomes, what factors enable a region to adjust and adapt over time?

The answer is likely to lie in a number of areas, with the relevant importance of each factor being different across regions and over time, but the sort of factors that appear to have been helpful in the past would include:

- a strong regional system of innovation,
- strength in factors that create a learning region,
- a modern productive infrastructure (transport, broadband provision, etc.).
- a skilled, innovative and entrepreneurial workforce,
- a supportive financial system providing patient capital,
- a diversified economic base, not over-reliant on a single industry.

The list could be added to, and the above factors are not exclusive, in that a skilled workforce will contribute towards the capability of being a learning region (see Martini, 2014) and likewise would be part of any successful Regional System of Innovation.

Thus, to the above, whether as additional factors or as contributory factors to the broad categories, could be added successful universities with strong links between the universities and the regional economies (see Triple Helix Model); close collaborative relations between companies and with other organizations, locally and globally; high levels of trust among and between economic actors; a supportive regional government promoting the above factors, actively networked nationally and internationally, combining regional industrial policy and innovation policy into regional innovation strategies.

Wolfe (2010)'s study of two cities concludes that: The most effective strategies for regional resilience rely on acquired levels of civic capital and the existing endowment of regional institutions to hart new paths forward […]. Thus, one might say that regions make their own resilience, but they do not make it as they please; they do not make it under self-selected circumstances, but under circumstances existing already, given and transmitted from the past (Christopherson *et al.*, 2010: 6-7).

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