New challenges for hydrogeological risk, among established and emerging paths. The case of 'Timpa di Acireale'

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Abstract

Hydrogeological risk is one of the major challenges that a community must face to be resilient to water-related disasters. Italy is highly vulnerable to hydrogeological risk and for this reason the issue has assumed ever greater importance in planning and has involved the need for implementing measures to make the territory safer. Generally, planning tools and action for adapting to hydrogeological risk are based on technical paradigm, that seems to be insufficient and inadequate. The era of Anthropocene, the sudden changes taking place and their unpredictability put us in the conditions to plan in ever-increasing uncertainty. This has led more and more scholars to talk about resilience as a new 'strategy' to redefine the ways of adaptation. In this paper I intend to reflect on the traditional approach to risk management and the new challenges, starting from the need to strengthen the relationship between technical-scientific knowledge and common knowledge for a real integration of resilience approach in local governance practices. The case reflects on the initial work led by a local environmental organisation, in a natural protected area La Timpa di Acireale (Sicily), in

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which different actors are implementing different approaches to face the problem.

Keywords

Hydrogeological risk, Resilience, Participation, Collective learning, Protected Area

Introduction

Hydrogeological risk is one of the most complex challenges that communities have to face in the time of the Anthropocene. The level of gravity of a flood is affected by many factors: quantity of precipitated water, land use, geomorphological characteristics of the watershed. The occurrence of a disastrous flood is also characterized by anthropogenic factors: the ability of the population to be prepared and the ability to build a path that can prevent the occurrence of social, environmental and economic damages (Rossi and Benedini, 2020). Italy is a country highly vulnerable to hydrogeological risk and in recent decades we have seen the increase in frequency and intensity of events proved disastrous. For this reason, the issue of flood risk management has become increasingly important in planning and has led to the need to take measures for a safer territory. The planning approach to hydrogeological risk is still mainly based on a linear relationship of knowledge and action, which is expressed through measures, forecasts, zoning, the requirements and identification of actions necessary to increase the factors for securing the territory. So, today, the reduction of hydrogeological risk is mainly in two directions, either in the implementation of an

existing defence system or with the construction of new one (Vitale et al., 2020).

There is an attempt in some fields of the social sciences to build a counterpart to this approach. Research in this area has focused mainly on the perception of risk, developing through two main independent directions. The first one is oriented to the deepening of the elements of descriptive nature and to the analysis of the social behaviour in front of the occurrence of natural risks. The second one focuses on understanding how communities perceive technological advancement to reduce the risk rate (Saitta, 2009).

However, these approaches have not explored a topic of practice relevance, which looks at how to integrate these forms of knowledge with technical-scientific ones.

To look at literature, therefore, it is evident that the goal of some approaches in social sciences was to typify and classify individuals and their behaviours. On the other hand, hard sciences are limited to transforming the reality into mathematical variables, in an attempt to develop increasingly complex models capable of making predictions useful for designing safety measures and infrastructures. In both cases we see a simplification of reality in which the sentimental and experiential components of the value system are not taken into account together with purely technical factors.

This paper aims to reflect on the need to strengthen the relationship between technical-scientific knowledge and common knowledge for a real integration of resilient action in local planning practices. The paper presents some preliminary results of an ongoing research carried out on the case of La Timpa, in Acireale (Sicily), in which researchers from the fields of environmental planning and hydrology are working closely with non-profit associations, community, schools, adopting a transdisciplinary and action-research approach (Saija, 2017). The objective is to identify specific

community learning strategies for building resilience to hydrogeological risk.

The current planning tools for risk mitigation in Italy

In planning, the traditional tools used to manage hydrogeological risk are tied to ways of thinking typical of hard sciences and the concerning unidirectional nature of knowledge production that exists between the "expert" and the "plan".
In planning this means that the action and choices of planners or designers are based on the expert knowledge that they are able to produce, it is the result of a rational intuition able to translate stable and universal values in the form of utopia or model (rationalism) or the result of rigorous analyses and codified procedures capable of indicating what the necessary conditions are for a given pre-constituted objective to be achieved. This paradigm can also be found in the main planning tools that has been produced in recent decades in Italy.
The frequent combination of floods and landslides has led to develop a normative and planning apparatus that looked at the defence of the soil in a comprehensive way and Law 183/1989 is its expression. Law 183/89 introduces elements to start a rational, planned and overall management of the water resource. One of the principles on which it is based is to operate on the scale of the river basins, with the aim of overcoming the difficulties of planning the water resource, caused by the fragmentation in territorial areas defined by purely administrative boundaries. In order to plan the management and use of water, Law 183/89 introduces the River Basin Plan tool that is conceived as a tool to collect relevant information and to identify the needed actions for

(1) flood defence and soil conservation, (2) water supply for different uses and (3) pollution control of water bodies (rivers, lakes and aquifers) (Rossi and Benedini, 2020). The Basin Plan, which is binding and over-ordered to other planning tools, contains comprehensive plan, articulated in "structural and mandatory" decisions, with low degrees of flexibility and legitimized by the highly technical-scientific profile of the Basin Authority (Bobbio, 2006). The Basin Plan, in its implementation, has found multiple difficulties due to the wide cognitive activity necessary, the complexity of its approval procedure and facing the difficulties moving among different scales, where often the choices taken at a regional scale collide with emerging interests at a local level. In the specific topic of hydrogeological risk, this stalemate was overcome with the drafting of the Hydrogeological Asset Planning (PAI). The PAI is oriented to the identification and classification of the main hydraulic hazard and risk areas and existing infrastructures and to identify the new ones to reduce risk. The contents are divided into structural measures and non-structural measures (land use rules and behaviour norms).
In short, the Basin Plan and the PAI are, essentially, technocratic plans, designed to prevail over any other plan, inspired by the logic of the hierarchy of interests.
At urban scale, the flooding issue is getting more and more attention, due to the presence in urban context of a high number of people and property exposed to hazard. So, in order to adapt to hydrogeological risk, technological solutions have been developed, consisting in the construction of green or blue infrastructures (BGI), in addition or for replacing the traditional drainage system already existing. Green and blue infrastructures are a way for creating sustainable drainage systems (SuDS) aiming at restoring the water cycle and increasing the levels of

hydraulic invariance through the provision of high infiltration capacity infrastructure, which aim to combine the needs of water disposal with the possibility of increasing green and/or blue surfaces (Dieperink et al., 2018; Moccia and Sgobbo, 2013). All this is part of actions that should be carried out mainly by the hands of the public sector or through building regulation instruments and incentive mechanisms that give to the private individuals the opportunity to act in order to improve the invariance hydraulics in the field of private property. However, even in this case it is possible to see a gap between theory and practice. In Italy, the issue of planning for urban adaptation to flooding risk is not yet a priority for many local administrators (De Gregorio Hurtado et al., 2015; Gobattoni et al., 2017). This seems to confirm what Innes and Booher had claimed back in 1994, that the choices of planning and public policy are based on systems of social cognition of problems that are often distant from scientific knowledge and strongly conditioned by common sense and structures of power (Innes and Booher, 1994). In summary, therefore, we can observe that despite innovations in terms of objectives and tools, the paradigm with which risk is faced today is purely technical, with a strong propensity for structural solutions, in obedience to a vision defined "hydraulic paradigm" (Barbanente and Monno, 2005), that inclines more to the continuous promotion of public infrastructure (Becchi, 1990). In the meantime, victims, damage and, not least, investments (albeit limited) for infrastructures that seem ineffective *per se*, would be avoidable, implementing prevention and planning strategies that do not relate only to traditional planning approaches, but which also look at planning practices that relate to new paradigms, capable of adopting new rationalities and methods (Dyckman, 2019).

A shift of paradigm: Anthropocene and evolutionary resilience

The Anthropocene era (Crutzen, 2002) we live in, in which it is certain that human is no longer separable from nature. The sudden changes taking place and their unpredictability puts us in the conditions to plan in ever-increasing uncertainty. Anthropocene uncertainties and climate change are now endogenous factors of human history that individuals, communities, governments, must deal with when putting down choices of future planning. It is not possible to predict the effects of this status, both in the medium and long term, neither the changes that climate change will determine. The imperative of uncertainty has led more and more scholars to talk about resilience as a new "strategy" to redefine the ways of adaptation. Strategies are intended as a process by which consolidated practices are questioned. The concept of resilience is originally used in the field of physics and engineering to describe a material ability to return to its original characteristics, after an alteration of its balance. The same concept will be then introduced in the field of ecology, in the 70s of the twentieth century by Holling that defines resilience as "Measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables" (1973, p. 14). The initial scope of Holling's work is very important because he first sets a breaking point between the engineering resilience paradigm, as a condition of balance and stability of components, and the new idea of resilience, influenced by the theory of complexity (Bateson, 1973; Bocchi and Cerruti, 1985), which is no longer linked to a static and unique equilibrium concept of the system, but focuses more on

what is unpredictable and on the study of factors that are contingent and non-deterministic (Davoudi et al., 2012).
A few decades later, the concept of resilience is further expanded and influenced by the theory of complex adaptive systems (Levin, 1998), so the ecological interpretation of resilience takes on additional characteristics, also applied to Socio-Ecological Systems (SES) (Gunderson and Holling, 2001), to describe the relations between human community and non human, biotic/abiotic communities. Holling himself and the Resilience Alliance group define resilience through these three features:
1 - The amount of change that a given system can endure while maintaining the same control
2 - the capacity of the system to increase its ability to learn and adapt to change.
3 - the capacity of the system to self-organize and transform.
In this theoretical framework, the concept of resilience does not imply a return to an initial state but is rather related to the ability of the system not only to receive stress, but also to change and transform, opening up to new opportunities.
Since Holling's work, the concept of resilience has involved multiple disciplines, becoming an increasingly broader and unclear concept. In the literature we find the concept of resilience in many other fields, from social disciplines (Adger, 2000) to economic disciplines (Rose, 2004) and also in planning resilience is now a buzzword (Davoudi 2012). Although its fluidity has facilitated the transition and a growing familiarity with this term (Brand and Jax, 2007), the application of the concept of resilience to planning shows problematic nodes and implications, especially when it comes to environmental issues, in particular issues that have to do with environmental risks and climate change and the adoption of strategies to adapt to them (Pizzo, 2015). There is criticisms about the ambiguity in the use of that concept,

that holds together things that are also very different from each other: in this sense it risks losing meaning and have a mere evocative value, a "empty signifier" (Weichselgartner and Kelman, 2015). This means that when we talk about resilience, it is necessary to contextualise it.

This paper looks at resilience in its evolutionary meaning (Davoudì, 2013). Being resilient, an adaptive process doesn't bring us back to how we were before, but to a change of perspective. A SES, that can be considered resilient, has not only transformed its physical environment to respond to external disturbances. It is a system where activated processes led to an higher level of awareness, with the aim of understanding the reasons and the modalities underlying the desired transformation and, therefore, it is able to develop new strategies of transformation needed in a highly mutable world.

In line with what Adger (2003) wrote, adaptive capacity is the ability of a community to cooperate in order to deploy climate change adaptation actions taking advantage of potential opportunities, thus becoming the path of adaptation in the attempt to use changes and uncertainties as an opportunity to bet on a new desired future framework. This means that the evolutionary approach to adaptation, defined in assonance with the evolutionary resilience of Davoudi (2013), is not a way of being, but the trigger to start transformative actions.

In the specific case of a process in which the objective is to be resilient to hydrogeological risk, we move from the paradigm of protection and security from flood risk to one that, in a complex way, uses the necessity of having a territory safer for triggering transformative actions that can be opportunities also in other fields. In this sense, the attribution of roles, knowledge and responsibilities are fundamental factors in the success of the adaptive capacity

process. To this end, many scholars (Armitage et al, 2008; Pelling, 2010) see in the mechanisms of collective learning a key to start a path of resilience that leads to the maturation of new values, ideas, rules, choices that constitute a new basis for social life.
First of all, we are all embedded in a SES, this means that each one has its own role and no single person can face the deep understanding of system issues, so it is auspicial to get different sources of knowledge that allow to better navigate SES (Shava et al., 2010). For decades it has been assumed that for environmental problems learning produces a linear effect in changing people behaviours and ways of thinking, but it has been suggested that it is not. Namely, a continuous collective learning permits to reflects on political and social aspects of environmental issues and develops a value framework for orienting actions of evolutionary resilience. Continuously-changing features of complex SES need a continuous updating of information and knowledge, with the aim of refining and transforming people behaviours, institution or management practices (Shultz and Lundholm, 2010).

Community learning as a way to building resilience

Learning is one of the topics of planning, a long planning tradition has been based on the idea that planning tools are devices with which people learn new ways of life, guided by the design logic that underlies the production of the plan. This has been manifested in the risk field, through unidirectional information transmission with the aim to ensure that the citizen acquires behaviours capable of making her/him safe in the extreme event or with the aim of building consensus for one technical solution rather than

another. In the case of this paper we look at those forms of learning that consider the process for which the construction of the community value system (Friedman, 1989; Healey 2006) will be placed at the base of questions related to future transformations (Douglas et al., 2018; Saija, 2012). The idea collective learning refers to is not passive learning that arises from having undergone external action, but is an active type of learning capable of triggering a process through which the community learns to recognize and tries to fill the gap that exists between the triggering causes of imbalance alteration and the ability of the system to respond to such alteration.
In literature we found Double Loop Learning (Argyris and Shon, 1978). At a first level, the concept of learning implies the acquisition of knowledge or skills and implies the achievement of two possible different moments:
a) the acquisition of skills or know-how, which implies the ability to perform some action;
b) the acquisition of awareness or know-why, which is inherent in the ability to develop a conceptual understanding of lived experience.
Beyond this first level, second level or autopoietic processes can be initiated, in which the system not only learns to respond to external stresses but is also able to transform, through an autopoietic process of re-organization of the system itself (Maturana and Varela, 1980).
In this light, the learning process is such that all those who are part of it have the opportunity to meet, confront and "learn collectively:
a) what is important/right/good to do to address a given problem (first level learning)
b) learning to learn, or developing the ability to deal with possible future problems (second-level learning or deutero-learning)" (Saija, 2017, p. 46, transl).

A process of collective learning has also the goal of enhancing various perspectives and forms of knowledge and also allows common knowledge to take a cognitive value.
In line with Funtowicz and Ravetz (1993) an approach based on extended peer communities is proposed, in which values are no longer kept out of the analysis or data collection but are made explicit in a mutual respect between the various perspectives and forms of knowledge, which complement each other. Community involvement is a very important factor in risk management for many reasons. When assessing the risk itself, the technical approach looks at numbers, experimental evidence, forecasts that have a value as objective and predictive as possible, and they influence the policy choices for addressing the risk problem. However, as mentioned above, the risk also depends on factors very different from those used to extrapolate the numbers of prevention. The citizens, and in general, the "non-experts" influence their perception of risk with psychological and cultural factors, conditioned overall by direct experiences and asymmetric received information. If scientific analyses describe risk as exact and measurable fact, social sciences suggest that actually the psychological and cultural dimension of risk is strongly influenced by contextual factors (Renn, 1998). Last but not least, the widespread lack of capacity to address environmental issues encourages citizens to rely on experts and institutions for risk management, limiting themselves to the behaviour dictated by alarm systems and to exclude themselves from the problem. As a result, social sciences also show how this attitude of trust also leads to an excessive sense of security and to underestimating the real problems to which one is exposed (Felletti et al., 2017). These factors are too often considered optional, compared to the normal course of hydrogeological risk management strategies (Vitale et al., 2020) Instead, it

should become structuring factors of decision-making processes, rejecting the idea that the planning act is only the prerogative of experts, rather it is the result of a path made by a collective subject.

The case of the Timpa of Acireale

The case presented here refers to the protected natural area Timpa of Acireale, located in Sicily and the initial ideas related to MIPAT project, inevitably slowed down by the global pandemic of COVID-19. The choice to talk about this case is significant because allows to reflect on a tendency by the institutions to intervene for the safety of the territory, even in those portions that have particular natural value, with a predominance tendence on expert knowledge production, finalized to build new infrastructure, without actually looking at the problem in a complex way, both in terms of the extent of the phenomenon, or in terms of process. In contrast, a partnership that brings together universities, the third-sector world and citizens is experimenting a process that looks at risk as a manifestation of a territorial process (Magnaghi, 2012), with the aim of addressing the problem through multifaceted strategies.
The Timpa (Figure 1) is a narrow strip of territory, about 8 km long, that from the sea rises steeply up to about 180 m

Figure 1 - The extention of the Timpa (light and dark green area)

of altitude, formed as a result of Etna volcanic system movement.

From a geomorphological profile the Timpa represents a structure subject to the normal evolutionary dynamics of slope, that include repeated failures and/or more or less localized collapses of stone material, caused mainly by erosion by atmospheric agents and by surface runoff and infiltration water. In the case of the geological escarpment of the Timpa, the close presence of the town of Acireale, together with the dense road network that connects the numerous smaller towns located in the urban area, means that important quantities of rainwater, conveyed along these widespread waterproof surfaces, reach the edge of the Timpa from which they fall in a disorderly manner. In this context, the lack of an efficient urban drainage system and the high amount of runoff means that rainwater can affect the stability of the scarp. An efficient form of control over this type of disruption was in the past exercised through the assiduous practice of agricultural activity along the escarpment. In fact, agricultural terracing was an active form of defence, since any falling blocks stopped by sinking into the horizontal surface formed by the agricultural land contained in the terracing. Their continuous maintenance ensured over time an effective barrier against the danger of collapses and detachments of rocky material. The current state of neglect of agricultural terraces is a considerable danger, because it allows the effects of many small collapses to be added, with the accumulation along the slope of large quantities of rocky blocks in precarious equilibrium conditions, destined to landslide giving rise to larger disturbances than the initial small collapses. A similar argument can be made for the waters circulating on the ridge, which were once regulated for agricultural purposes, while currently flow freely along the slope.

The institutional perspective

In this already complex framework, the latest PAI update many areas of the reserve, like the areas of hazard P3 and P4 and with risk R3 and R4, from "high" to "very high" rate of risk. Following this classification Ordinance No.07 of 26 April 2019 of the Regional Office of Territory and Environment prohibits the use of the areas below the escarpment. In response to this problem and in order to plan risk mitigation actions, the municipal administration has recently commissioned a study to geotechnical researchers team, with the aim of assessing the 'state of health' of existing flood infrastructures that have been built in the Timpa and planning new ones with the aim of reducing the risk classes of the PAI.

However, there are some limitations that need to be stressed here. Existing retain structures (retain walls, micro-piles, etc.) or active defensive interventions, such as adhesion nets reinforced with steel wire and/or high-strength mesh panels, have been the result of an emergency action that lacks an overall and programmatic vision of the hydrological risk management of the area. In addition, over the years, the continuous landslides caused by torrential rains have shown that these works are not entirely effective and, in many cases, have had negative effects on the protection of biodiversity and the landscape. At last, the attention of the city administration continues to look at portions of territory defined by legal and administrative limits, the reserve one. In the specific case it looks at the reserve taking into account only what happens within its perimeter without looking in a complex way to the causes of risk that must be resolved upstream of the reserve itself, in urban context.

In the adaptation processes, as in this case, the institutions mainly adopt a rational approach in which they are guided

by predefined objectives, for which knowledge is gathered in order to model and predict future scenarios and on the basis of these, a strategy is implemented to minimise the flooding risks. To act in such a way implies a strengthening, more and more over time, of established values, norms and cumulative consolidated knowledge base, limiting in fact the possibilities of future choice. It takes place what Krasner (1988) has defined path-dependency organizational room, where adaptive capacity is reduced to linear forms of knowledge and action that limit the range of possible choices on adaptation measures. In the contingency of events, decision-makers could implement alternative strategies, but the same options are chosen as used in past events because they constitute institutional practices that are accepted by common sense (Parson et al., 2019). Such choices are culturally specific practices that respect both formal rules and norms, as well as cognitive structures and worldviews that influence the understandings and actions of decision makers. Maintaining the institutional *status quo* often requires the constant maintenance of coalitions of stakeholders and interest groups in support of institutions (whose values and knowledge reflect those of the social hegemonic group) to ensure the defence of the continuation of existing policy responses (Johnson et al., 2005).

The community perspective

A paradigm change in risk management implies to produce forms of knowledge that are based on the ability to cooperate of various actors, leading not only to increasing the amount of knowledge but to a reorganization of those values, those rules and objectives that permit to make an effective change of perspective. The opportunity for the Circolo Legambiente (an environmental organisation) to

experiment a more complex path was the publication of the call for project by Foundation for the South, – Environment 2018 call, that promotes adaptation activities to environmental risks, but with a multifaceted vision, as reported on the call text:

"Effective reduction of environmental risks cannot, therefore, be achieved without the development of widespread local networks, which promote public policies with environmental protection objectives, that active citizenship paths that contribute to the maintenance and enhancement of virtuous behaviour and good practices. It is therefore essential to actively involve communities living in protected areas and in the surrounding areas, through the promotion of initiatives and mechanisms that are able to encourage the spread of behaviour aimed at the care and protection of the environment" (Fondazione con il Sud, 2018).

The need to think about such a project has given rise to many questions about the best approach to handle the vastness of the information, data, cultures, permanencies, emergencies that are parts of a territory telling and starting point for a project that can become a transformation path (Adger, 2003). The will was to go beyond the mere environmental issue and give voice to a story able to describe the socio-ecological dynamics that over the centuries have given shape and structure to the territory. A starting point was the desire to adopt a multi-disciplinary approach that offers different reading layers for the interpretation of this portion of the territory so rich in diversity. The elements of natural preservation become unique with the factors of cultural enhancement (Gambino, 2010). The relationship between permanence and change is the fulcrum around which the instances of the project revolve. The attention to what has been seen and still is possible to see, is closely

linked to the theme of the identity of the territory, factors of stability that have given meaning to places (Decandia, 2000). The project 'M.I.P.A.T. (Hydrological Mitigation Landscape Environment Territory) starts from an integrated concept of territorial heritage, treating the territory as a subject open to continuous relations, activating interactions and exchange between different actions and disciplines (Magnaghi, 2012) and interpreting risk as a manifestation of suffering of a complex system. The project is supported by a diversified partnership: University of Catania (Department of Agriculture, Food and Environment and Department of Civil Engineering and Architecture), Ecoscience (Biologists association), Circolo Arci Babilonia, Fondazione Città del Fanciullo (training centre), Acireale Municipality and Sicily Region Department of Rural and Territorial Development. The collaboration of the partners within the project has allowed the development of a multidisciplinary approach, which draws resources from the world of research, institutions and active citizenship. Cultural, social and scientific competences have the aim of creating a network of people and put in action all the goals written below. To do this, attention has been paid to how multiple sources of knowledge put into cooperation can contribute to building complex knowledge frameworks (Funtowicz and Ravetz, 1993) on adaptive and resilient capacities of the territory to face the challenges of hydrological risk. One of the key points is to rediscover traditional construction techniques of agricultural infrastructures and agriculture activities, which in the past have ensured the daily care of a delicate ecosystem such as La Timpa. It is planned to empower the resumption of citrus cultivation and traditional infrastructure with courses of agro-ecology and traditional building aimed at training young people. The goal is to build a base of operators able to promote a path that restarts

agricultural activities, now suffering, with the aim of bringing agriculture to the role of sentinel and care of the territory. To this economic dimension, educational demonstration of bio-engineering site (Petrone and Preti, 2010) is programmed in order to start a debate about the possibility to intervene for hydro-geological risk adaptation with techniques that are able to integrate with the ecosystem cycles. In addition, the workshop of territorial animation and environmental education laboratories are a further contribution to the prevention and adaptation of risk. The next step will be the realization of a community map (Saija and Pappalardo, 2018), conceived as a transformative tool for developing a framework of shared values in a climate of collaboration, trying to turn each mapping subject into a member of a "investigating community" (Sclavi, 2004). The overall strategy of the project is therefore based on a direct approach to the critical issues highlighted in La Timpa, placing as a central element the local community and the network of operators and experts who support it. In this sense, the proposal focuses on *community learning*. Implemented direct actions on and with the territory and sharing the urgency and importance of prevention are aimed to creating a path of active citizenship to reclaim the right to be part of a democratic governance, as an institutions-community mechanism, inspired in general by the value of participation and in particular by the studies of Ostrom (1990) and the so-called Landscape Agreements (Pizziolo, 2009).

Conclusions

Hydrogeological risk is a complex challenge that we all face. Despite events tell us that we are in a highly mutable

world, the ways followed by decision-makers tackles hydrogeological risk continuing to foster consolidated engineering approaches (Lawrence et al., 2015; Vitale et al., 2020). The guiding principles and cognitive processes that underlie the choices of securing the territory are mainly oriented to the development of a type of incremental knowledge rather than paradigmatic changes. A real and feasible process of 'prevention' and 'preparation' to hydrogeological risk, however, does not depend only on the ability to make the territory safer, rather it depends on a paradigm shift for which planning aims to build a path of resilience and adaptation. In order to ensure that hydrogeological risk is not only a problem but also an opportunity for change for socio-ecological systems, it is necessary to strengthen the relationship between technical-scientific knowledge and common knowledge, through collective learning processes. Elaborating risk-awareness frameworks and to creating a collective subject, capable of initiating a process of transformation, can have an effect in the medium and long term, not only on the problem of risk, but also to multi-purpose goals that can improve the condition of economic and social well-being. A complex adaptive pathway, as described above, requires an innovative and integrated approach to risk planning and management, based on an open and flexible learning process involving citizens, associations, experts and institutions in order to reach a socio-ecological revitalization, able to change the current established way of dealing with the risk and represents an opportunity for the future, putting the roots for a "new alliance" between human and nature (Prigogine and Stengers 1984). They are processes where social practices are integrated with the institutional ones for changing the physical spaces, the economic and social mechanisms in which they are emerging. From this point of

view, there is a need for research efforts that investigate the relationship between scientific knowledge and social cognitive systems.

References

Adger W. N. (2003), Social aspects of adaptive capacity, *Climate Change, Adaptive Capacity and Development*, pp. 29-49.

Argyris C., Schön D. A. (1978), *Organitational Learning: A Theory Of Action Perspective*, Boston, Addison-Westley.

Barbanente A., Monno V. (2005), Changing discourses, practices and spaces of coexistence: Perspectives for the environmental regeneration of the Ofanto River Basin, *Planning Theory & Practice*, 6,2, pp.171-190.

Bateson G. (1973), *Steps To An Ecology of Mind*, Chicago, University of Chicago Press.

Becchi A. (1990), Opere pubbliche [Public works], *Meridiana*, 9, pp. 223-243.

Bobbio L. (2006), Le politiche contrattualizzate, in Donolo C. (ed.) (2006) *Il Futuro delle Politiche Pubbliche* [*The Future of Public Policy*], Milano, Mondadori, pp. 59-79.

Brand F. S., Jax K. (2007), Focusing the meaning(s) of resilience: resilience as a descriptive concept and a boundary object, *Ecology and Society*, 12,1, pp. 23-39.

Bocchi G., Ceruti M., (eds.) (1985), *La sfida della complessità* [*Complexity Challenges*], Milan, Mondadori.

Crutzen P. J. (2002), Geology of mankind, *Nature*, 415, 23.

Davoudi S., (2012), Resilience: a bridging concept or a dead end? "Reframing", *Planning Theory & Practice*, 13,2, pp. 299-333.

Decandia L. (2000), *Dell'Identità. Saggio sui Luoghi: per una critica della Razionalità Urbanistica* [*Of Identity. Place Essay: for a Urban Rationality Critic*], Catanzaro, Rubettino.

De Gregorio Hurtado S., Olazabal M., Salvia M., Pietrapertosa F., Olazabal E., Geneletti D., Reckien D. (2015), Understanding how and why cities engage with climate policy: an analysis of local climate action in Spain and Italy, *TeMA. Journal of Land Use, Mobility and Environment,* 1, pp. 23-46.

Dieperink C., Mees H., Priest S., Ek K., Bruzzone S., Larrue C., and Matczak P. (2018), Managing urban flood resilience as a multilevel governance challenge: An analysis of required multilevel coordination mechanisms, *Ecology and Society*, 23,1, pp. 31-43.

Douglas E. M., Reardon K. M., Täger M. C. (2018), Participatory action research as a means of achieving ecological wisdom within climate change resiliency planning, *Journal of Urban Management*, 7,3, pp. 152-160.

Dyckmann C. (2019), Water resource planning. in Leigh N. G., French S. P., Guhathakurta S., Stiftel B. (eds.) (2019), *The Routledge Handbook of International Planning Education*, London, Routledge

Friedmann, J. (1989), Planning in the public domain: Discourse and praxis, *Journal of Planning Education and Research*, 8,2, pp. 128-130.

Felletti S., Bonelli L., Sapienza A., Falcone R., Paglieri F. (2017), Fiducia e rischi naturali: Inquadramento teorico e studi sperimentali [Trust and natural risks: Theoretical framework and experimental studies], *Sistemi intelligenti* [*Intelligent Systems*], 29,2, pp. 313-350.

Funtowicz S. O., Ravetz, J. R. (1993), Science for the post normal age, *Futures*, 25,7 pp. 739 -755.

Gambino, R. (2010), Parchi e paesaggi d'Europa. Un programma di ricerca territorial [European parks and

landscapes. A three-year research program]. *Ri-Vista Ricerche per la Progettazione del Paesaggio* [*Journal of Landscapes Design*], 14, pp. 3-20.

Gatto E., Saitta, P. (2009), Territorio e percezione del rischio. Un approccio interdisciplinare [Territory and risk perception. An interdisciplinary approach]. *Bollettino della Società Geografica Italiana* [*Journal of Italian Gheographic Society*], 2,2, pp. 381-401.

Gobattoni F., Pelorosso R., Piccinni A. F., Leone A. (2017), The sustainability of the urban system from a hydrological point of view: A practice planning proposal. *UPLanD-Journal of Urban Planning, Landscape & Environmental Design*, 2,3, 101-122.

Gunderson L. H., Holling C.S. (ed) (2001), *Panarchy: Understanding Transformations in Human and Natural Systems,* Washington, Island press.

Johnson C.L., Tunstall S.M., Penning-Rowsell E.C. (2005), Floods as catalysts for policy change: Historical lessons from England and Wales. *International Journal Water Resources Development*, 21, pp. 561–575.

Krasner S. D. (1988), Sovereignty: an institutional perspective, *Comparative Political Studies*, 21, pp. 66–94

Healey P. (2006), Transforming governance: challenges of institutional adaptation and a new politics of space. *European Plannning Studies,* 14,3, pp. 299–320.

Holling C. S. (1973). Resilience and stability of ecological systems, *Annual Review of Ecology and Systematics*, 4,1, pp. 1-23.

Innes J. E., Booher D. E. (1999), Consensus building and complex adaptive systems: A framework for evaluating collaborative planning. *Journal of the American Planning Association*, 65,4, pp. 412–23.

Lawrence J., Sullivan F., Lash A., Ide G., Cameron C., McGlinchey L. (2015), Adapting to changing climate risk

by local government in New Zealand: Institutional practice barriers and enablers. *Local Environment*, 20, pp. 298–320.

Levin S. A. (1998), Ecosystems and the biosphere as complex adaptive systems. *Ecosystems*, 1,5, pp. 431-436.

Magnaghi A. (ed.) (2012). *Il Territorio Bene Comune* [*Territory as Common Good*]. Firenze, Firenze University Press.

Maturana H., Varela F. (1980), *Autopoiesis and cognition: The realization of the living*, Boston, Reidel.

Moccia F. D., Sgobbo A. (2013), Flood hazard: planning approach to risk mitigation, *WIT Transactions on the Built Environment*, 134, pp. 89-99.

Ostrom E. (1990), *Governing the Commons. The Evolution of Institutions for Collective Actions*. Cambridge, Cambridge U.P.

Parsons M., Nalau J., Fisher K., Brown C. (2019), Disrupting path dependency: Making room for Indigenous knowledge in river management, *Global Environmental Change*, 56, pp. 95-113.

Pelling M. (2010), *Adaptation to Climate Change: from Resilience to Transformation*, London, Routledge.

Petrone A., Preti F. (2010), Soil bioengineering for risk mitigation and environmental restoration in a humid tropical area, *Hydrology and Earth System Sciences*, 14,2, pp. 239-250.

Pizziolo G. (2009). Da un'esperienza europea: Ruralscape, dai paesaggi rurali partecipati alla Regione Vivente [From a European experience: Ruralscape, from partipatory rural landscape to Alive Region], in Leone M., Lo Piccolo F., Schilleci F. (ed.), *Il paesaggio agricolo nella Conca d'Oro di Palermo* [*The Rural Landscape of Conca d'Oro in Palermo*], Firenze, Alinea, pp. 189-197.

Pizzo B. (2015), Problematizing resilience: Implications for planning theory and practice, *Cities*, 43, pp. 133–140.

Prigogine I., Stengers, I. (1984), *Order out of Chaos*, New York, Bantam.

Renn O. (1998), Three decades of risk research: Accomplishments and new challenges, *Journal of risk research*, 1,1, pp. 49-71.

Rose A., (2004), Defining and measuring economic resilience to disasters, *Disaster Prevention and Management*, 13,4, pp. 307-314.

Rossi G., Benedini M. (2020), *Water Resources of Italy*, Berlino, Springer

Saija L. (2017), *La ricerca-azione in pianificazione territoriale e urbanistica* [*Action research in urban and terrritorial planning*], Milan, Franco Angeli.

Saija L., Pappalardo G. (2018), An Argument for Action Research-Inspired Participatory Mapping, *Journal of Planning Education and Research,* doi: 10.1177/0739456X18817090

Sclavi M. (2004), Quando la costruzione di common ground è un problema di ordinaria amministrazione [The construction of common ground as ordinary affair problem], *Territorio,* 29-30, pp. 281-189, Milan, Franco Angeli.

Schultz L., Lundholm C. (2010), Learning for resilience? Exploring learning opportunities in biosphere reserves, *Environmental Education Research*, 16,5-6, pp. 645-663.

Shava S., Krasny M.E., Tidball K.G., C. Zazu (2010), Agricultural knowledge in urban and resettled communities: Applications to social–ecological resilience and environmental education, *Environmental Education Research,* 16, pp. 575–589.

Vitale C., Meijerink S., Moccia F. D., Ache P. (2020), Urban flood resilience, a discursive-institutional analysis of

planning practices in the Metropolitan City of Milan, *Land Use Policy*, 95, 104575.

Weichselgartner J., Kelman, I. (2015), Geographies of resilience: Challenges and opportunities of a descriptive concept, *Progress in Human Geography*, 39,3, pp. 249–267.