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ELEMENTS OF INTEGRATION OF REGIONAL LANDSCAPE PLANNING WITH RISK MANAGEMENT PLANNING IN ABRUZZO

Abstract
The topic of Disaster Risk Management is increasingly central as a necessary action to pursue the objective of prevention and therefore the reduction of territorial risk levels, the effect of natural disasters and climate change. In the context of this theme, the research presented in this article focuses on the construction and experimentation of an innovative form of Regional Management Risk Plan based on a Spatial/Structural approach and on a broad Knowledge System on Multi-Hazards, Multi-Vulnerabilities and Multi-Exposures and consequently on Multi-Risks. The interaction of these components was studied to obtain the Risk Scenarios that were used to structure the so-called Spatial Prevention and Spatial Recovery Projects (PSRP) within the Hotspots. These PSRPs are the tools for the implementation of prevention/mitigation and recovery actions, and for the coordination (i.e. governance) of such actions with those of landscape protection typical of landscape planning. The application case study is that of the new Landscape Plan of the Abruzzo Region.

Keywords: risk, landscape, Regional Planning, disaster risk management, hotspot.

Introduction
Distaster Risk Management (DRM), an issue that involves many actors, factors and scales [1, 2, 3, 4, 5], is increasingly central to Spatial planning, as a necessary action to pursue the objective of prevention and therefore the reduction of territorial risk levels, the effect of natural disasters and climate change. In the context of this theme, the research presented in this article [6] focuses on the construction and experimentation of an innovative form of Regional Management Risk Plan (RMRP) [7] based on a semi-quantitative [8, 9] approach referring to an index-based multi-risk analysis scheme [10], adopting however the simplification of not taking into account the interactions between the Risks (cascade effect), as it happens in methodologies based for example on matrices, event trees, Bayesian networks, time stepping Monte Carlo simulations, etc. [11]. Moreover, from a planning point of view, it refers to a Spatial/Structural approach and on a broad Knowledge System on Multi-Hazards, Multi-Vulnerabilities and Multi-Exposures and consequently on Multi-Risks [11, 12]. It is a Basic Knowledge System, oriented to the assessment [13], derived from data and information from official (institutional or scientific) sources [14, 15, 16, 17], organized and managed by a specific platform whose model is being tested [14].
The interaction of these components has been interpreted with the aim of obtaining multiple Risk Scenarios that have become the basis of Prevention and Spatial Recovery Projects (PSRP) within Hotspots. These PSRPs represent the tools for the implementation of prevention/mitigation and recovery actions, and the tools for coordination (governance) with the strategies for the protection of the landscape, but also with those oriented to socio-economic development, thus adding to the RMRP also a strategic meaning and attention to the landscape components of the territory.
The article deals in particular, for the case study of the Abruzzo Region and within the Hotspots, with the interface between PSRPs and strategies for landscape valorisation and quality. In fact, the research explores the field of integration of the actions of prevention and mitigation of the Risk connected to the hazards of physical origin with those of reduction of the Landscape Risk, the latter connected to the impact of the PSRPs. The final objective is to conceptually evolve the RMRP, since to its character specifically oriented to the reduction of the effects of natural disasters, there is also the social, identities and aesthetic one connected to the value of the Landscape.
The research attempts to address one of the main gaps in the scientific literature on the topic of DRM. Indeed, most scientific studies in this field address a single Hazard, a single Vulnerability or a single Exposure [11]. That is, multiple components are not taken into account. Instead, our research refers to the concepts of Multi-Hazard (M_H), Multi-Vulnerability (M_V) (distinguishing Vulnerability in the anthropic and environmental components, this is another innovation we propose), Multi-Exposition (M_E) and therefore Multi-Risk (M_R) which is more properly considered as Multi HVE Risk. It also attempts to address at the regional scale the relationship, little investigated, between Multi-Risk, its reduction and mitigation and its impact on the landscape. The European Landscape Convention states that each Party undertakes "to integrate landscape into its regional and town planning policies and in its cultural, environmental, agricultural, social and economic policies, as well as in any other policies with possible direct or indirect impact on landscape". It does not directly mention hazards, vulnerabilities or risks but introduces the concepts of impact and landscape quality to which our research refers [18].
The following sections briefly describe the methodology adopted for the definition of the RMRP, its integration with Regional Landscape Planning and related policies, the main research results and conclusions.

Methodology
The research refers to a shared language on interdisciplinary issues of risk from natural and man-made disasters. This language is based on the contents of the UNESCO document "Consultative meeting of experts on the statistical study of natural hazards and their consequences" of 1972 [19] and the United Nations document "Natural disaster and vulnerability analysis" of 1979 [20]. These documents introduce the concept that (R) Risk is a function of (H) Hazard, (V) Vulnerability and (E) risk elements (Exposure),

$$R=f(H,V,E) \quad (1)$$

There are numerous formulations of Risk in the scientific literature. The traditional one, recalled by the EC in 2010 and the scientific literature [21], foresees that the Risk can be obtained as follows:

$$R=H\times V\times E \quad (2)$$

But there are many variations. In our methodology the formulation adopted is a simple function, in which the interaction between the risk components is based on the sum of the relevant indicators, that is:

$$R=H+V+E \quad (3)$$

Multiplying these indicators, as written in formula (2), could greatly accentuate the parts of the territory at high risk, while concealing those at medium or low risk, which in our research, however, are not considered negligible. Moreover, it was decided to adopt the formulation (3) because the scale of the

study is regional (1:25,000) and it is able to bring out complex areas (Hotspots) instead of punctual situations.
In the model we propose, Hs (seismic, flood, landslides, avalanches, anthropogenic, dams and fires), Vs (natural areas, settlement, population classes), Es (population, settlement expansion areas) and Rs (combination of the previous components) are georeferenced spatial elements, classified as high, medium and low. Each of these classes has been associated with a numerical weight that has allowed formula 3 to be applied.
Figure 1 describes the general methodology applied for the construction of the RMRP model. It provides an initial collection of geographical knowledge, in GIS format, of the three elements that make up the Risk, HVE. They are originally vectorial geographical coverage, which have been converted into raster format to allow the analysis with a semi-quantitative approach and the consequent identification of the Risk Scenarios. The latter have been differentiated into two large groups, those affecting the Environmental/Landscape system and those affecting the anthropic/settlement system.
The Knowledge System effectively expresses a synthesis of numerous Risks, Vulnerability (differentiated in Environmental/Landscape and Anthropic/Settlement) and Exposure, thus determining Multi-Hazard (M_H), Multi-Vulnerability (M_V) and Multi-Exposure (M_E). This approach modifies the formula (3) in:

$$M_R = M_H + M_V + M_E \qquad (4)$$

Formula 4 takes into account that we are dealing with the complex combination of Multiple Hazards (M_H), Multiple Vulnerabilities (M_V) and Multiple Exposure types (M_E). This combination results in Multiple Risks (M_R) that allow us to identify Risk Scenarios through we can select risk treatment options, a topic explored in both the defence and financial fields. For example, ISO 31000:2018 “Risk management – Guidelines” lists seven risk treatment options: (1) avoiding the risk by deciding not to start or continue with the activity that gives rise to the risk; (2) taking or increasig the risk in order to pursue an opportunity; (3) removing the risk source; (4) changing the likelihood; (5) changing the consequences; (6) sharing the risk (e.g. through contracts, buying insurance); (7) retaining the risk by informed decision [22]. The RMRP refers to the third and fourth options, corresponding to medium or high risk areas, and to the seventh option, corresponding to low risk areas, thus assuming that the latter is an acceptable level of risk [22].
The identification of Risk Scenarios allows two types of actions to be planned, the first concerns Prevention actions, the second concerns Mitigation actions and therefore Risk Control. In our methodology these actions have also been differentiated according to the main land use classes, i.e. natural/semi-natural use, urban use and agricultural use.
By selectively overlaying the Risk Scenarios, it is possible to identify the so-called ‘Hotspots’,

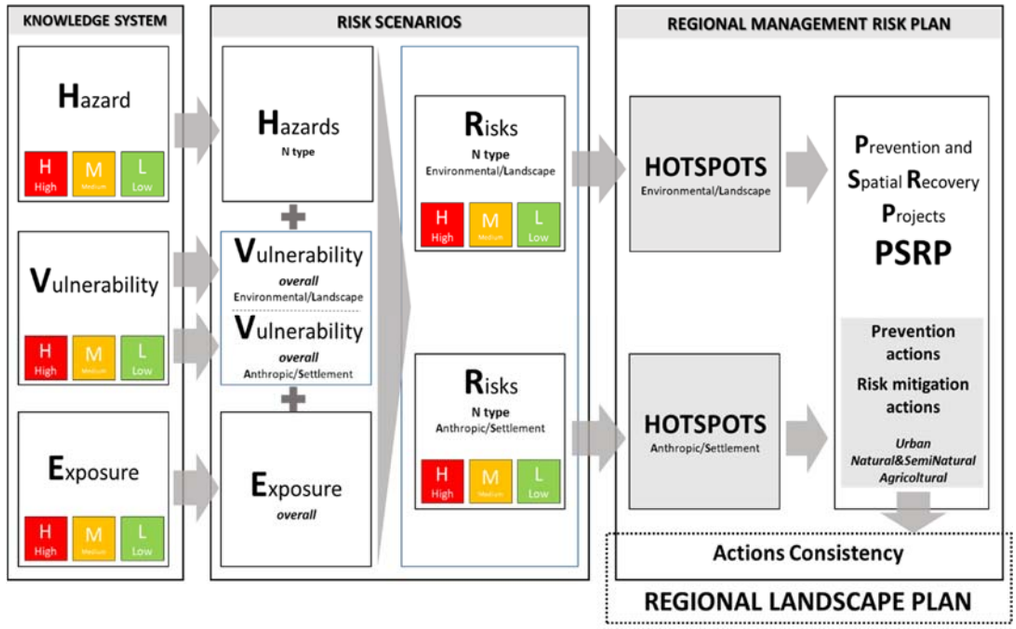

Fig. 1. The methodology: Regional Management Risk Plan - RMRP and Regional Landscape Plan.

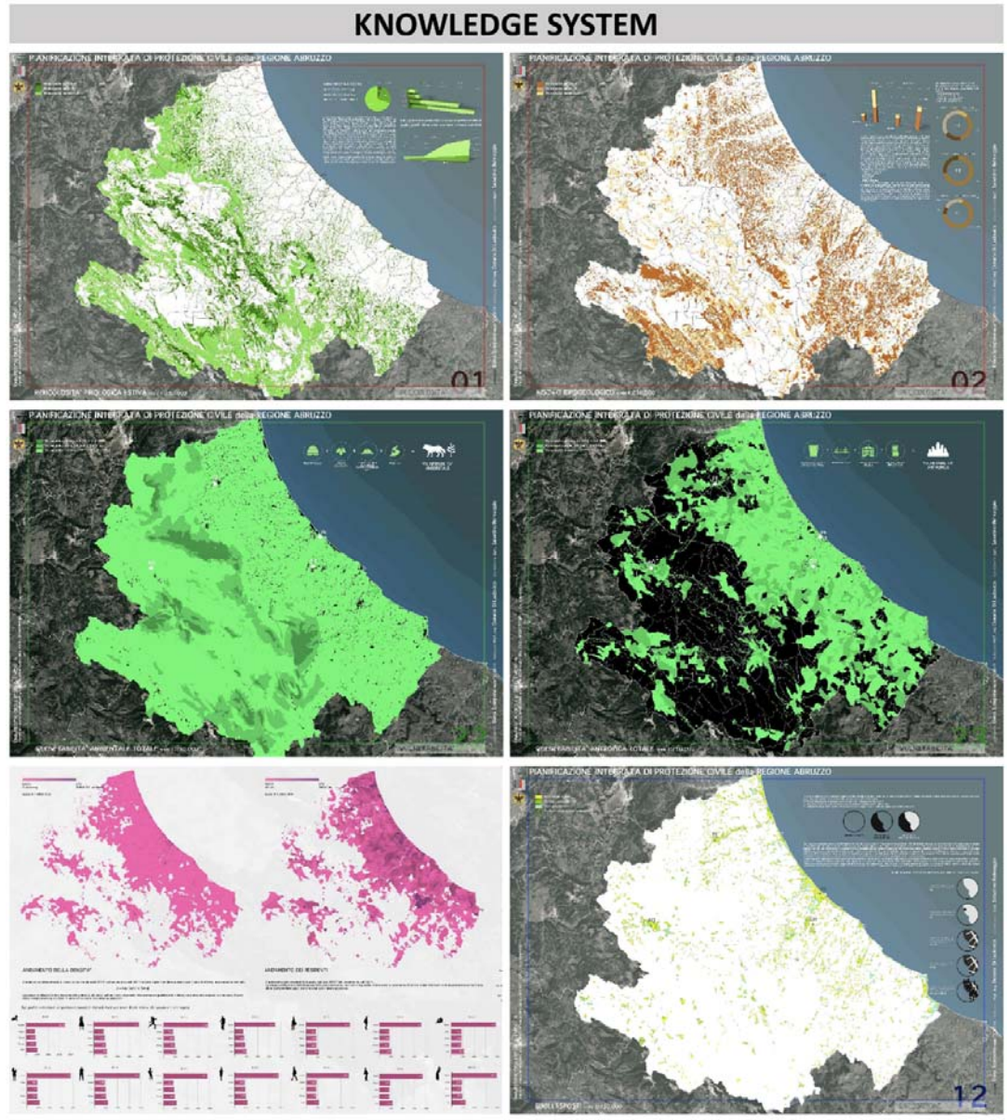

Fig. 2. The Knowledge System of Risks in Abruzzo Region. Top: the Wildfire Hazard (left), the Landslides Hazard (right). Middle: the Vulnerability EL - Environmental/Landscape (left), the Vulnerability AS - Anthropic/Settlement (right). Bottom: Real population Exposure (left), Potential population Exposure (Right) (elaboration: Elena Scarpone).

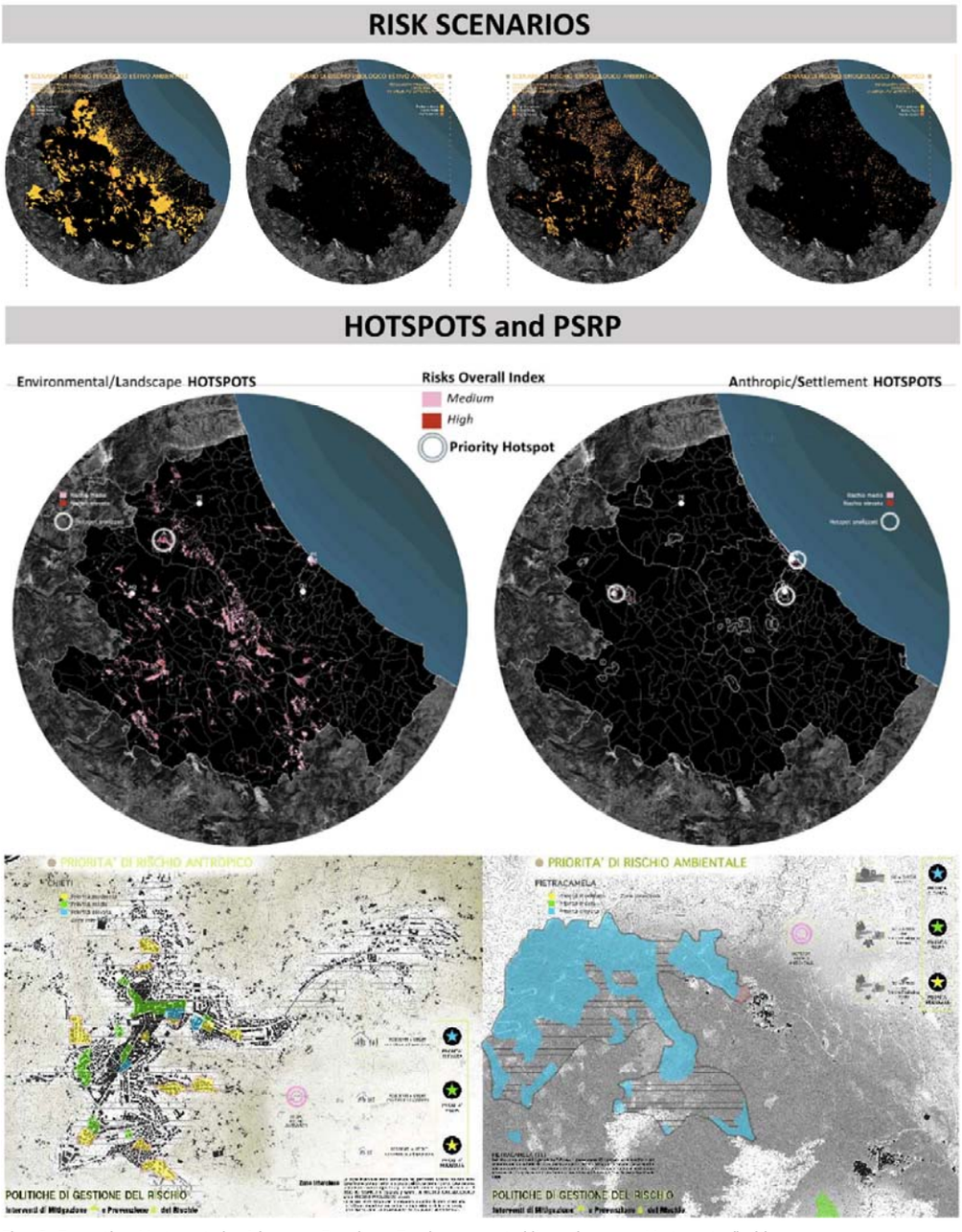

Fig. 3. Top: the Hotspots in Abruzzo Region: Environmental/Landscape Hotspots (left), Anthropic/Settlement Hotspots (right). Bottom: PSRP in Environmental/Landscape Hotspot (left); PSRP in Anthropic/Settlement Hotspot (right) (elaboration: Elena Scarpone).

i.e. more or less large areas in which there is a preponderance of high risk combinations, therefore high priority areas in which to intervene through the Spatial Prevention and Spatial Recovery Projects (PSRP) that include spatial prevention/mitigation and recovery interventions with low impact and consistent with the objectives and strategies of the Landscape Sector Planning, in accordance with the art. 5 of the European Landscape Convention [18].

The integration of the RMRP with the Abruzzo Region's Landscape Plan

Figures 2 and 3 represent the application of the methodology described in Figure 1 to the case study, the Abruzzo Region.

Figure 2 shows examples of the contents of the Knowledge System. These are the Wildfire Hazard map (top left), the Landslides Hazard map (top right), the Total Environmental/Landscape Vulnerability map (middle left) and the Anthropic/Settlement Vulnerability map (middle right), the Real Population Exposure map (bottom left) and the Potential Population Exposure map (bottom right). More generally, the Knowledge System contains the following components:

- Hazard: Flood, Landslides, Historical Avalanche, Avalanche – susceptibility index, Contaminated areas, Potentially contaminated areas, Chemical-Industrial, Seismic, Dams and Wildfire.
- Vulnerability ES - Environmental/Landscape: Natural protected areas, Ecological value, Geosites, Coastal area, Soil pollution; Vulnerability AS - Anthropic/Settlement: High visibility areas, Archaeological heritage, Historical and Cultural assets, Road and technological infrastructures, Age of buildings and conservation status, Age groups population.
- Exposure: Real population, Potential population.

The combination of the above-mentioned components of the Knowledge System, through raster overlay GIS methodologies (Formula 4) as synthetically described in the previous section, allowed to obtain the Risk Scenarios. Figure 3 represents two examples of these, the Wildfire Risk Scenario (top left) and the Landslides Risk Scenario (top right), both differentiated into EL - Environmental/Landscape and AS - Anthropic/Settlement. The subsequent selective overlay of the Risk Scenarios allowed the identification of the Hotspots [23], the areas with the highest density of high risks, represented in Figure 3 in the middle (on the left the EL - Environmental/Landscape Hotspots, on the right the AS - Anthropic/Settlement Hotspots).

According to the methodology in Figure 1, the identification of Hotspots is followed by the definition of Prevention and Spatial Recovery Projects (PSRP), whose spatial interventions (design actions) aim to reduce risk through Prevention actions and Risk mitigation actions [24]. Figure 3 bottom, shows two examples of Prevention and Spatial Recovery Projects (PSRP), on the left an example related to the AS - Anthropic/Settlement themes, and on the right an example related to the EL - Environmental/Landscape themes. In fact, the methodology considers that Prevention and Mitigation actions are further differentiated according to the type of soil concerned (urban, agricultural, natural) and the urgency of their implementation (the urgency was expressed in terms of priorities). In this way it is possible to know which Prevention and Mitigation actions to implement first (high priority) and in which territorial area (Hotspot).

It should be underlined that PSRPs are design actions for the recovery and mitigation of risks in Hotspots. They are actions that can modify and transform spatial components and therefore the landscape. Consequently, the PSRPs cannot be only the composition of actions but must also assume the role of governance tools, i.e. coordination between mitigation and recovery actions with the landscape design strategies as provided by the Regional Landscape Plan, thus introducing in the RMRP also the contents and techniques of Landscape urbanism and Landscape design [25]. These techniques improve the prevention, recovery and mitigation actions taking into account their impact on the regional landscape, but above all deepening the theme of the landscape impact of these actions that, it cannot be denied, could negatively transform the landscape, degrading its values and therefore its identities. The application of Landscape urbanism and design techniques allows to correctly address the PSRPs, especially when we are faced with very impacting actions that create new landscapes.

It is therefore essential to direct prevention, mitigation and recovery actions to the attention of Landscape design [25]. In this sense, the Abruzzo Regional Landscape Plan, currently under preparation, pays such attention through

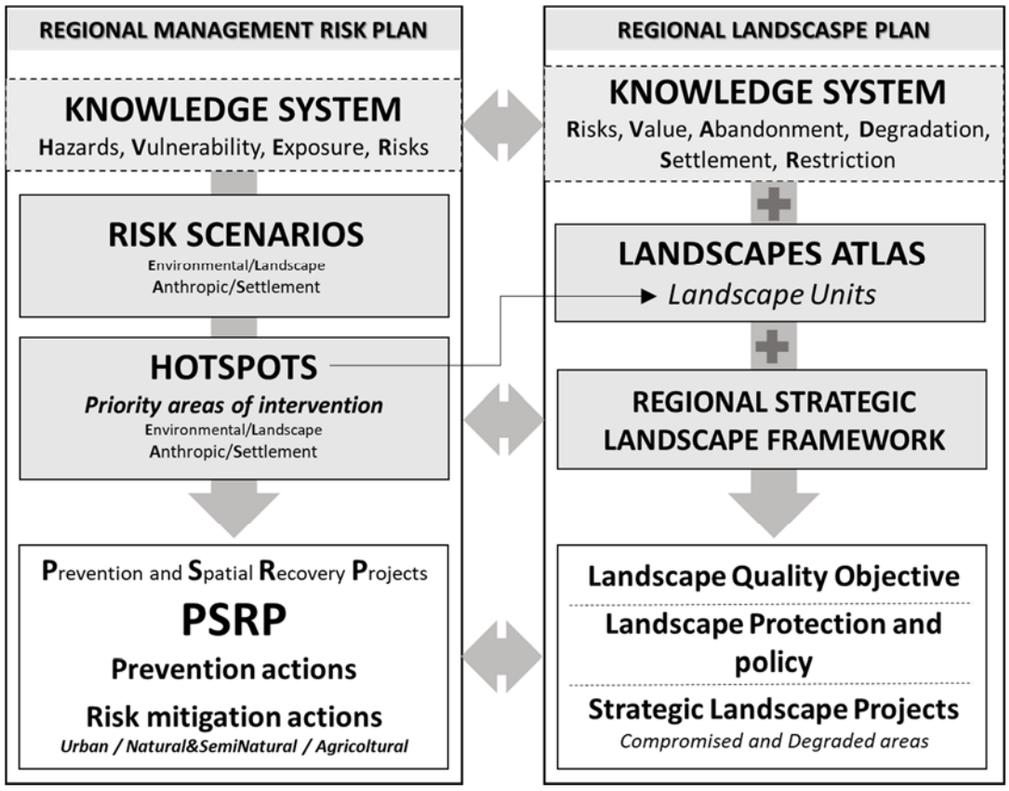

Fig. 4. Consistency of Regional Management Risk Plan with the Abruzzo Region's Landscape Plan.

three tools that also refer to the European Landscape Convention:

- Landscape protection and policies.
- Landscape quality objectives.
- Strategic Landscape Projects [26] on compromised and degraded areas (also by risks).

The Landscape Plan of the Abruzzo Region in this way integrates the protection aspects with the design and strategic aspects of the landscape. In particular, what our research is interested in is making consistent the Strategic Landscape Projects with the PSRPs. This step is represented in Figure 4, in which the contents of the RMRP are compared with those of the Regional Landscape Plan. Thus, the Hotspots are related to the Landscape Units and consequently the Strategic Landscape Projects to the PSRPs. Spatial project actions in PSRPs are given a strategic value and therefore must be treated in terms of design and landscape quality, as they give rise to new landscapes. These aspects, which are currently under study, make the RMRP conceptually evolve, since to its specifically managerial character is added also the strategic/design one derived from the Regional Landscape Plan.

Results and Conclusion

The article described, albeit briefly, a wide-ranging research concerning Disaster Risk Management (DRM) at a Regional level (NUTS 2). Following the path Risk Mapping → Assessment → Planning, a Regional Management Risk Plan (RMRP) model was proposed using a case study of the Abruzzo Region. The main result of the research was therefore an RMRP model that is characterised by several innovative aspects. First of all, it is based on a Knowledge System, oriented to the assessment of multiple Hazards (M_H), multiple Vulnerabilities (M_V) and multiple Exposures (M_E), which does not exist in the scientific literature (is written only of M_H). Then, in its analytical application, the model is characterised by an index-based Multi-Risk (M_R) analysis scheme [10] that refer to a semi-quantitative approach and lead to the identification of differentiated Risk Scenarios for the Environmental and Anthropogenic contexts. Moreover, the planning model for Disaster Risk Management, which characterizes the above mentioned model, refers to a hybrid approach, spatial-structural and evaluative-performance. Another element of innovation concerns the actions of the RMRP that are carried out through Prevention and Spatial Recovery Projects (PSRP) within Hotspots, i.e. complex areas significantly at risk determined by a selective overlay of Risk Scenarios. These PSRPs are carried out through design actions in the following fields: prevention, mitigation and recovery, which are coordinated with the protection, conservation and design actions of the Regional Landscape Plan. This is a circular and dynamic process, addressing the issue of risk planning with a holistic approach, interfacing the theme of management with those of the project/design, spatial transformations and their impact on landscape (which recalls the concept of sustainability [27]).

Therefore, the RMRP is not a Plan in its own right, but instead uses the concept of consistency and co-planning to achieve its integration with other sectoral planning, not necessarily oriented to the management of phenomena, such as landscape planning, which is a type of plan oriented to conservation and valorisation, including socio-economic, as indicated by the European Landscape Convention. This aspect, which we have addressed in the research by defining a tool for verifying the consistency of prevention and mitigation actions with those of the Regional Landscape Plan, also involves the issue of risk governance, which concerns multiple actors and decision-makers across other planning areas, whose contribution has not yet been analysed and can be dealt with by extending the Knowledge System Platform with communication and participation tools.

Among the limits found in the experimentation phase, certainly emerge those concerning the choice of numerical value of the index variables used to define the Risk Scenarios, as well as their combination to identify the Hotspots. Changing the numerical value can also substantially change the configuration of the scenarios. In order to avoid this effect, extensive balancing work was carried out to identify Hotspots of the correct regional dimension. This is the issue called "representation as reduction", which was already addressed in the 1960s [25, 28].

The next steps of the research concern some in-depth studies and developments:

- The deepening of a digital platform for the Knowledge System dedicated to M_H, M_V, M_E, but also to territorial values, necessary when dealing with dynamic phenomena such as risks, which change over time. The platform will be addressed to governance management and therefore to communication and participation.
- The revision of the indicators will also take into account the dynamism of catastrophic events (time variable), their multi-scalarity and the cascading effect of hazards, as well as the impact on the landscape.
- The experimentation on a concrete case of the coherence between PSRPs and - Strategic Landscape Projects.

Acknowledgement

The research is carried out within the framework of an Agreement between the Abruzzo Region (DPC - Servizio Prevenzione dei Rischi di Protezione Civile) and the DICEAA - University of L'Aquila, which provides for the research project "Analysis and management of data related to seismic risk prevention in the territory of the Abruzzo Region". Collaboration: Phd Luana Di Lodovico.

The maps in Figures 2 and 3 were elaborated by Elena Scarpone.

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