New Cohesion Policy 2021–2027: The Role of Indicators in the Assessment of the SDGs Targets Performance

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Abstract. The paper deals with the usefulness of indicators and indices in assessing the performance of a city or territory with respect to the Sustainable Development Goals (SDGs) and their targets, in the context of the new European cohesion policy 2021–2027. An impact matrix has been developed in order to measure the performance of each indicator in achieving the SDGs and their targets in a real case study: the municipality of Rivoli, located in Piedmont region, which is currently involved in the programming of European and National recovery funds. The proposed model on the one hand can support the decision-making process in the assessment and monitoring procedures and on the other hand it can be of interest of technicians and freelances to simplify and optimize the conventional planning procedures to present project proposals of territorial transformation and with respect to the building of strategies with medium and long perspective. In this sense, this first application can determine the usefulness of the method to assess in a simple way the wide range of potential impacts, considering both the quantitative and the qualitative scale.

Keywords: Indicators · Indices · Impact matrix · Cohesion policy · Sustainable development

1 Introduction

Governments are only recently approaching to the envisioning of future transformations according to a transformative perspective, related to both resilience and sustainability paradigms [1]. They progressively revolutionized the traditional planning, top-down based, to the strategic planning characterized by a place-based approach and learning by doing vision. In the meanwhile, International and European organizations solicited European country members to intervene on the environment health, to prevent and mitigate natural hazards, to avoid catastrophic implications of the ongoing climate change [2–6]. In 2020, this awareness has been emphasized by COVID-19 pandemic, that revealed new needs and services (or known needs but put aside for the fast city lifestyle). With regard to the Italian context, if the urban standards revealed unable to satisfy the citizens

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demand, especially in big and medium-sized cities, COVID-19 pandemic has accentuated this aspect, from the need of diffuse green areas to sustainable infrastructures that connect cities and territories both inside and outside. Mismatches between governance and environmental outcomes must be solved more than ever [7]. Environment must become the engine of urban and territorial transformations of the next years. Considering the different pressures to which urban systems are exposed, different policies aim at providing strategies and solutions, supporting the municipalities in giving the instrument and guidelines to achieve sustainability and resilience [8–10]. In this context, it is inserted the New Cohesion Policy 2021–2027 [11]. It is grounded on four main pillars, (1) the quality of work, (2) the environment and the natural resources for the future generations, (3) homogeneity and the quality for citizens services and (4) the culture for economic and social cohesion. Moreover, these pillars represent concrete challenges for the future development of cities, that are strictly related and coherent with the SDGs and their targets. As an example, the pillar related to the environment and the natural resources specifically concerns the evaluation of the impacts that natural hazards (i.e. floods, earthquake, landslide and climate risk) should have on citizens. As well as, the pillar of the economic and social cohesion is coherent with the SDG 11 that aims at creating more sustainable cities and communities [12]. Within this context and targets, the evaluation process becomes fundamental since the definition of the suitable actions to achieve both the sustainability and resilience. Thus, assessment frameworks able both to examine the impacts of actions in the ex-ante phase and to monitoring their effects over time are required. The main task is providing tools that can support the decision-making process, according to its main objectives [13]. The present research develops an impact matrix, able to analyse the performance of different urban components related to the risk (R) in achieving the SDGs and their targets. Moreover, this paper illustrates the first application of this matrix to the real case study of the municipality of Rivoli, Italy.

2 Methodology

Evaluation frameworks can provide reliable support for the decision-making process in solving complex problems that affect cities and territories [13], and identifying strategic guidelines and recommendations for the planning and programming of medium and long-term strategies. Evaluation methods employ suitable tools that may be developed individually or in synergy with others, thanks to their versatility, from energy retrofit assessment [14] to smart eco-districts [15], or even healthcare facilities [16], among others. The paper provides an evaluation model that combines a set of indicators in order to measure climate risk features and their impact with respect to the achievement of the SDGs and their targets through an impact matrix. The combination between the two tools can support the design of strategic guidelines for projects to be presented in the 2021–2027 EU cohesion policy programming.

2.1 Components of Risk

The concept of risk (R), that refers to the of the probability of hazards, is generally described as the function of three fundamental elements, which are the hazard (H), that describes the potential occurrence of both natural and human-induced physical events that should imply damages, the vulnerability (V) that is conceived as the sensitivity of a given area to shocks or disturbances that interact with the area under investigation and the exposure (E) of all those elements that detains a social, economic and cultural value [3, 17, 18]. In this sense, the understanding and the assessment of risk, especially when climate features are included, require a comprehensive knowledge on social, economic and cultural values, as well as interactions between different actors and stakeholders [19].

2.2 Indicators and Indices

Indicators and indices play a fundamental role when they are employed within evaluation models. They can provide a measure of certain aspects of a phenomenon as well as an overall interpretation of the phenomenon recorded at a given time, by aggregating them through weighting and aggregation formulas [20–22]. Their wide application ranges from social inequality of distribution (i.e. Gini index) to environmental and climate change performance (i.e. EPI and CCPI), until to indices that are integrated as parameters of mathematical models to predict future scenarios [23] or to be integrated within tools such as System Dynamic Models [24].

The employment of indicators and indices within assessment and planning procedures are ever more retained fundamental for the monitoring of the environmental impacts derived by the actions of plans, programs and projects of urban and territorial transformations.

2.3 Impact Matrix

Tools like impact matrix usually support environmental assessment procedures of plans, programs and projects because they can help the understanding and the visualization of the impacts that anthropogenic activities generate on the individual environmental components and on the whole environmental system. Impact matrix can use qualitative scale (such as low, medium, high), quantitative scale (such as from 1 to 3), or symbols (e.g. – and + to label positive or negative impacts) and it can combine qualitative-quantitative evaluation to support properly the assessment. It can be applied by considering the state of the art of the territory under investigation and can refer to the potential planning scenarios that will inspire the design and/or the revision of plans, programs and projects, following both sustainable and resilient development principles. In fact, procedures like the strategic environmental assessment (SEA) [25] usually employ the impact matrix to investigate the internal and external consistency. In the application provided in this paper, the impact matrix recalls the external consistency of the SEA procedure because evaluates the set of indicators with respect to the SDGs.

3 Application

3.1 Case Study: The City of Rivoli

This paper illustrates the application of the proposed method to the municipality of Rivoli, that it is located in Piedmont region (Italy). In details, it belongs to the metropolitan city of Turin and it is far 14 km from Turin. Figure 1 illustrates the territorial framework of the municipality of Rivoli. Thus, the municipality of Rivoli can be considered as a natural conglomerate of the city of Turin. In fact, most of the settlements are allocated along the main streets that connect Rivoli to the city of Turin. Thus, the case study has been selected for this application in accordance to its level of accessibility to the city of Turin that is the main municipality of the analyzed metropolitan area. Moreover, this interest is also justified by the recent transfer of the people into the cities of the first belt of the metropolitan city of Turin, after the COVID-19 pandemic. This transfer is mainly due to the necessity of a better quality of life, always referred to the pressures to which the urban areas are mainly exposed.

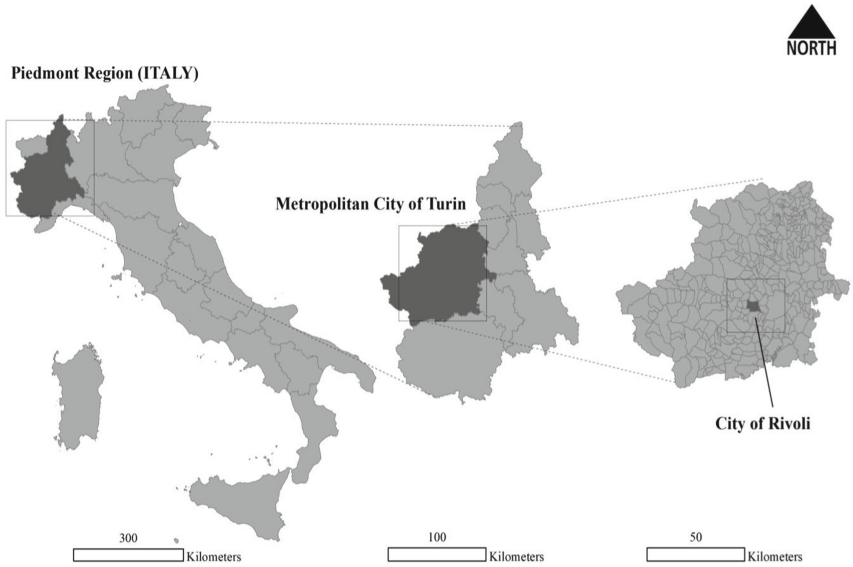

Fig. 1. Territorial framework of the city of the municipality of Rivoli (Italy)

3.2 List of Indicators

As above mentioned, this paper proposes an impact matrix to assess the performance of different urban components in enhancing the SDGs goals and their targets. For this purpose, a list of multidimensional indicators concerning the risk and specifically related to hazard, vulnerability and exposure has been developed.

As mentioned in Sect. 2, the risk (R) can be described as a combination of three different components. In details, risk can be evaluated through this formula:

$$\text{Risk(R)} = f(\text{H}, V, E) \tag{1}$$

Where:

- H represents the potential occurrence of a natural or man-made event, that should cause loss of life, health impacts, as well as damages and losses to infrastructures, service supply and environmental resources. In details, these hazards strictly depend on the localization of the analyzed urban system. Thus, for each cities the specific hazards have to be identified;
- V concerns the vulnerability of the urban system, or rather the predisposition of the city to be adversely affected;
- E stands for the level of the exposure to the risk of infrastructural assets of the urban system. For instance, it includes the presence of people, environmental services and resources, as well as economic and social services.

Table 1 lists the indicators that have been recognized to assess the risk of the municipality of Rivoli. In fact, they are specifically performed to the conditions and to the context of this municipality. For example, the indicator "Ecological fragmentation" means the incidence of impermeable barriers and built-up areas with respect to the total surface of the municipality. This specific indicator is measured in a scale between 0 and 1, where 0 labels low ecological fragmentation, whereas values near to 1 underlines a high fragmented ecological system. It can be calculated by using the Copernicus Corine Land Cover and GIS methods. However, the Regional Agency for Environmental Protection (Arpa) provides this type of indicator. Another example is the indicator "Statical condition" and its calculation closely depends on architecture survey and inspections. It can be applied to figure out the state of the art of building heritage and assumes particular importance in post-disaster events to know the buildings statical condition. An operative sheet is usually employed and filled by freelances and operators in the field [19]. If the two mentioned examples are considered "refined" indicators, due to the specific knowledge and expertise required for their calculation, other indicators can be considered simpler like the "inactive population" or "cultural heritage" because the data for their measurement is available and monitored by the main national and regional data sources without requiring refined calculations.

3.3 Impact Matrix

This paper proposes an impact matrix to assess the performance of the defined set of indicators (Table 1) on the SDGs and their targets. Impact is conceived as any modification to the environment, negative and/or positive. This concept has been adapted to the aim of the paper to investigate the impact of the indicators performance in terms of facilitation or impairment of the SDGs achievement. Positive impacts can facilitate this achievement, whereas negative impacts may limit or undo it. The direct impacts, positive or negative, label direct correlation between the i-th indicator and the SDG target, whereas the indirect impact, refers to an indirect link between them.

Table 1. List of indicators related to hazard, vulnerability and exposure

Components	Indicators	Description	Unit	Source
Hazard (*H*)	*H.1.* Increase of hot days/frost days	The indicator measures the number of hot and frost days that overcome the annual average threshold	No. days/year	Arpa Piemonte
	H.2. Annual precipitation variation	It considers the precipitation variation detected in a year	%	Arpa Piemonte
Vulnerability (*V*)	*V.1.* Inactive population	It considers the number of inhabitants with less than 14 y.o. and with more than 65 y.o	No	ISTAT
	V.2. Fragile inhabitants	It counts the inhabitants who require medical and/or social/health assistance	No	ISTAT
	V.3. Production activities of I and II sectors	It refers to the number of activities related to the 1st and 2nd economic sectors (i.e. agriculture and industry)	No	ISTAT
	V.4. Ecological fragmentation	It measures the incidence of impermeable barriers and built-up areas with respect to the total surface of the considered territory	0; 1	Arpa Piemonte, Copernicus CLC
	V.5. Age of building	It refers to the age of buildings as an indirect measure of the percentage of buildings that may be affected by serious damages after a disaster	Year	Geoportale Piemonte

(*continued*)

Table 1. (*continued*)

Components	Indicators	Description	Unit	Source
	V.6. Statical conditions	It measures the statical conditions of building heritage through architectural surveys and inspections	0; 1	Computed after Appiotti et al., 2020
Exposure (*E*)	*E.1*. Total population	It measures the total number of inhabitants in the considered territory	No	ISTAT Census
	E.2. Strategic buildings	It counts the number of public buildings retained as of strategic importance in case of disasters (e.g. hospitals, schools)	No	Open Street Map
	E.3. Economic activities	It counts the number of economic activities that contribute to the building of the Gross Domestic Product (GDP)	No	ISTAT
	E.4. Infrastructures	It records the linear kilometers of infrastructures in the territory under investigation	Kml	Geoportale Piemonte
	E.5. Environmental components	It considers the state of environmental components and standardize them into an average value between 0 (bad) and 1 (good)	Average state 0;1	Arpa Piemonte
	E.6. Cultural heritage	It records the number of protected cultural assets in the considered territory	No	Geoportale Piemonte

In detail, this impact matrix allows to assess both the positivity or negativity of the impact and if it is direct or indirect.

Table 2. General structure of the Impact matrix to assess SDGs' target performance

SDGs	Target	Hazard		Vulnerability						Exposure					
		H.1	*H.2*	*V.1*	*V.2*	*V.3*	*V.4*	*V.5*	*V.6*	*E.1*	*E.2*	*E.3*	*E.4*	*E.5*	*E.6*
SDG 1	1.1														
	1.2														
	1.3														
	1.*n*														
SDG *n*	n.1														
	n.2														
	n.3														
	n.n														

Table 2 illustrates the general structure of the proposed matrix. As it is possible to see, the matrix puts in relation the different SDGs and their targets to the different indicators related to hazard, vulnerability and risk. Thus, it is possible to determine which typology of impacts the indicators can have on the achievement of the SDGs and their targets.

Table 3. Focus of the Impact Matrix related to the SDG 11

		Hazard		**Vulnerability**						**Exposure**					
SDGs	**Target**	*H.1*	*H.2*	*V.1*	*V.2*	*V.3*	*V.4*	*V.5*	*V.6*	*E.1*	*E.2*	*E.3*	*E.4*	*E.5*	*E.6*
SDG 11	11.1				-					-			+		
	11.2			+	+					-	+		+	+	
	11.3							-	+	-	+		+	+	+
	11.4			+	+		+	+	+	+	+		+	+	+
	11.5			+	+	+	+			+		+			
	11.6	+	+				+			+	+	+	+	+	
	11.7			+	+		+			+	+	+	+	+	+
	11.A					+	+			+			+	+	
	11.B	+	+	+	+		+	+	+	+	+	+	+	+	+
	11.C			+	+					+					

Moreover, Table 3 reports a part of the compiled impact matrix. This illustrates the part that concerns the SDG 11 "make cities and human settlements inclusive, safe, resilient and sustainable". In details, the evaluation matrix assesses the positivity or negativity of the i-th impact on the SDG, and if their effects are direct or indirect.

Specifically, the color blue represents the direct impacts, while the color grey labels the indirect impact. Thus, in order to better understand how read this matrix, the symbol " + " in blue color represents a direct and positive impact, while the " +" in grey color stands for positive and indirect impacts. This reasoning is valid also for the negative impacts. While the white cells stand for no interaction between the indicator and the considered targets.

Moreover, some specific comments can be addressed in order to better explain the functioning of the matrix. As an example, the indicator *H.2* "Fragile Inhabitants" should have a negative direct impact on the target 11.1 that is referred to ensure to all the adequate access to safe and affordable housing and basic services. As well as, the indicator E.1 that is referred to the total of population. In fact, the number of the total population is too high, it can be very difficult to ensure the adequate quality of life to all.

Instead, the indicators *E.2* and *E.4* that are respectively referred to strategic buildings and infrastructures have a direct positive impact on the target 11.3 that concerns the inclusive and sustainable urbanization. The indicator *E.6* that involves the cultural heritage has a positive and direct impact on the target 11.4 that addresses the problem of the safeguard of the world's cultural and natural heritage.

4 Discussion of Results

The impact matrix has been applied to the municipality of Rivoli and the considered indicators have been selected according to the peculiarities of this urban system. Developing the assessment through this matrix, it was possible to address that the main significative SDGs and targets for the city of Rivoli are the following:

- the SDG 3 that concerns the ensure healthy lives and promote well-being for all at all ages. This interest is mainly due to the COVID-19 pandemic, that underlines the necessity and the urgency in intervening in this perspective;
- the SDG 4 that aims at ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all. This goals is fundamental, according to the transfer of a great number of people to municipalities of the first belt of the city of Turin. In fact, these municipalities should adapt their offer in educational field, according to the increasing of the demand;
- the SDGs 6 and 7 that are referred to the sustainable management of water and sustainable energy respectively are important in order to align the management of the municipality of Rivoli in reference to the pillar of the new cohesion policy 2021–2027 referred to the environment and the natural resources for the future generations. As well as for the SDG 8 that aims to promote inclusive and sustainable economic growth, that is coherent with the pillar of the new policy related to the quality of work;
- the SDG 11 that has been described in-depth in the previous sections, in order to contribute in creating an inclusive and sustainable city and community;
- the SDG 13 that concerns the urgency in taking appropriate actions for climate change. This goal within its targets can have an important role for the city of Rivoli, in which different stations to study the dynamic behavior and changes of the climate are located [26].

5 Conclusion

The presented evaluation model has revealed useful to assess the performance of the city of Rivoli in achieving the SDGs and their targets, thanks to the integration between the set of indicators and the impact matrix. Looking at the internal consistency of this model, the set of indicators allowed to focus on specific features of the city of Rivoli and may aid Decision-Makers in better interpreting complex dynamics such as climate risk factors. The impact matrix can identify the typology of impacts, directed or indirect, positive or negative, with respect to the achievement of the 17 SDGs and their specific targets. In this sense, it may be considered a useful support for the planning and programming of urban and territorial transformations, according to a medium and long term perspective. In fact, the structure of the proposed matrix is flexible, and the considered indicators should be chosen and performed according to the peculiarities of the analyzed urban system. In this sense, the proposed matrix may support Decision-Makers in designing projects proposals and prioritize the so-called "flag projects" that will lead the future transformation of the city. Considering the external consistency of the model, it may effectively support real procedures of environmental impact assessments, especially in the consistency assessment the process and in the monitoring phase, thus identifying the impacts and their entity over time. In fact, this kind of evaluation should highlight the performance of the different actions in improving the condition of the urban system. In this sense, it can support the definition of the preferable actions (ex-ante, in -itinere phases) and monitoring their impacts within their realization (ex-post phase) [27].

The limits of this evaluation model may be related to the degree of knowledge required of analysis and assessment of the case study, in order to identify general and site-specific characteristics to be measured through sets of indicators [23]. It is should be noticed that the desktop modality is not the proper one to support the planning and programming, rather than the participatory modality that allows to be constantly supported with materials, observations and site-specific needs and expectations deriving from the participatory process. The limits defined before are related to some future perspectives on the refinement of this evaluation model. First of all, it is very important to support the preliminary territorial analysis with the context definition, to know the real actors and stakeholders of the territory [28] and to identify the key players of the process.

The future perspective of this research concerns the integration of this impact matrix with the Multi-Criteria Decision Analysis (MCDA). In fact, it should be useful to evaluate the results, giving to the different SDGs within their targets a different importance that will be specifically related to the context and to the evaluation objective. As an example, this evaluation framework can support the definition and the evaluation of alternative scenarios for the plan development, within the context of Strategic Territorial Plans as well as the revision of the Regional Territorial Plan (PTR). Moreover, this matrix will be considered to structure an Analytic Network Process (ANP) based approach to assess the prioritization of these objectives and targets according to specific alternative planning scenarios. A panel of actors and stakeholders will be involved in the identification of meaningful and smart indicators, according to structural, qualifying factors and criticalities of the territories, but also indicators that may reveal useful to measure the performance of the adopted strategic guidelines and recommendation over

time. The participatory modality of this evaluation model will be also supported by the scenario building and planning approach to identify alternative evaluation scenarios. The development of MCDA approaches will include both political and economic criteria to reach the best alternative scenario and then transferred it to the final users to support the receiving of economic financing and the begin of preliminary and executive design of projects.

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