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Sustainability assessment of the public interventions supported by the ReSTART project in the CITI4GREEN framework

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CITI4GREEN

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Summary

As part of the CITI4GREEN project, this contribution analyzes the public interventions contained in Re-START "Territorial Resilience of the Central Apennines Earthquake Reconstruction" assessing their impacts on the sustainability guidelines posed by the United Nations through the establishment of the 2030 Agenda and its 17 Sustainable Development Goals (SDGs). To do so, the paper applies the methodology developed in Cavalli et al. (2020, 2021) to the 1278 reconstruction, repair, and restoration works in the Italian regions of Abruzzo, Lazio, Marche, and Umbria, affected by the seismic events of 2016 and 2017. The results are a clear priority given to Goal 4, "Quality education," which accounts for the 24.2% of the investments that af-fect the Agenda. Goal 11, "Sustainable cities and communities" takes the second place with 19.8%. Goals 14 “Life below water” and 7 “Affordable and clean energy” are, respectively, last and second last. All the three pillars of sustainability — environmental, social, and economic — are embraced by the public interventions. However, clear priority has been given to social and environmental sustainability. The economic dimension results under-represented. Additional policies are needed to ensure a more integrated sustainable develop-ment.

Keywords: sustainable development, SDGs, cohesion policy, public finance, sustainability assessment

JEL Classification: R58, H83, C43, Q56

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Sustainability assessment of the public interventions supported by the ReSTART project in the CITI4GREEN framework

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SUMMARY

As part of the CITI4GREEN project, this contribution analyzes the public interventions contained in Re-START "*Territorial Resilience of the Central Apennines Earthquake Reconstruction*" assessing their impacts on the sustainability guidelines posed by the United Nations through the establishment of the 2030 Agenda and its 17 Sustainable Development Goals (SDGs). To do so, the paper applies the methodology developed in Cavalli *et al.* (2020, 2021) to the 1278 reconstruction, repair, and restoration works in the Italian regions of Abruzzo, Lazio, Marche, and Umbria, affected by the seismic events of 2016 and 2017. The results are a clear priority given to Goal 4, "*Quality education*," which accounts for the 24.2% of the investments that affect the Agenda. Goal 11, "*Sustainable cities and communities*" takes the second place with 19.8%. Goals 14 "*Life below water*" and 7 "*Affordable and clean energy*" are, respectively, last and second last. All the three pillars of sustainability — environmental, social, and economic — are embraced by the public interventions. How-ever, clear priority has been given to social and environmental sustainability. The economic dimension results under-represented. Additional policies are needed to ensure a more integrated sustainable development.

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1. Introduction

In the last decade, data-driven decision-making has been praised as the point of convergence between management and scientific research by both public and private institutions. However, in many areas, data integration is still in the early stages. The sustainability field advocates for quantitative approaches to assess future developments and propose a course of action. When data is lacking, the only possible solutions are mixed qualitative-quantitative models.

After briefly discussing existing methods for sustainability assessment, the paper proceeds by applying Cavalli et al. (2020) [1] to the public interventions contained in the ReSTART project ("*Territorial Resilience of the Central Apennines Earthquake Reconstruction*").

This research explores the contribution that the reconstruction, repair, and restoration interventions in the Abruzzo, Lazio, Marche, and Umbria regions, that were hardly impacted by the 2016-2017 Central Italy earthquakes, have in relation to the Sustainable Development Goals of the 2030 Agenda. The study applies the 2030 Agenda either as a comprehensive and as a granular indicator for sustainability, as suggested by the European Commission and used in previous works.

Evaluation methods for sustainability assessment can have a wide-ranging approach, or they can be applied to specific works or policies. By the nature of this research, the authors have looked for an assessment method that could go to a granular level to evaluate the sustainability impacts of a single public work, such as the construction of a single building. At the same time, the authors have aimed at scaling up and summarizing the results and linking them to the Sustainable Development Goals (SDGs).

Methods that track SDGs achievement exist. However, most of them focus on a macro level. The Sustainable Development Report [2] publishes the 2030 Agenda's targets' yearly achievements worldwide or national level. Similarly, the SDGs tracker [3], by the Global Change Data Lab, in partnership with Our World in Data, uses data from the latter to update data visualizations keeping a record of SDGs' achievements at a national level.

Perlingeiro et al. (2019) [4] analyzed the literature for "criteria for the assessment of the sustainability of public constructions." They identified the four most-cited sustainability assessment tools, mainly used by the private sector at the time (they are still present): BREEAM, LEED (Leadership in Energy and Environmental Design), SBtool (Sustainable Building Tool), and Green Star. However, these tools are expensive, and the details of the evaluation process are kept behind closed doors, requiring a leap of faith by the final user. Therefore, outputs of heterogeneous inputs are impossible to compare.

In short, sustainability assessments use SDGs for macro estimates while specific evaluations are left to other tools, mostly private.

Since 1998, the Development Assistance Committee (DAC) of the Organization for Economic Co-operation and Development (OECD) has set up the Rio markers system [5], consisting of markers to monitor and statistically report on the development finance flows targeting the themes of the 1992 Rio Conventions. From the early 2010s, the European Commission started using Rio markers to measure its environment and climate-relevant spending (EC, 2014) [6] and provide statistical reports. The original Rio markers have three possible scores indicating whether the Rio Convention themes are (0) not targeted, (1) a significant objective, or (2) a principal objective of the action. The EU has decided to use 0%, 40%, and 100%, respectively. [7]

In 2014, Moro et al. [8] went one step further to develop a strategic environmental assessment methodology. In addition to indicating whether a finance flow has direct or indirect impacts on a specific goal, they have introduced the idea of evaluating the magnitude of this impact to achieve the goal itself. Including financial flows in the methodology's equation, Moro et al. [8] were the first to evaluate how much the resources spent helped (or not) the achievement of the sustainable objectives the entities in charge of the public works posed themselves.

In 2015, the United Nations created the 2030 Agenda, an integrated framework to indicate a direction toward sustainability. In 2019 and again, in 2020, the European Commission asked publicly to explore developing a methodology for monitoring the EU budget in terms of SDG (EC, 2020) [9]. With many years of expertise in the field of sustainability and SDGs [10-14], Cavalli et al. (2020) [1] responded to the request and developed a new methodology to evaluate the sustainability of operational programs co-financed by the EU for the Autonomous Region of Sardinia (RAS). This methodology, more comprehensively described in the next paragraph, expands and unites the Rio Markers [5] and Moro et al. (2014) [8]. Cavalli et al. (2020) [1] leverages the strengths of past methodologies and applies them to the 169 targets of the 17 Sustainable Development Goals of the 2030 Agenda. By doing so, Cavalli et al. (2020) [1] results more scalable than the others described. Cavalli et al. (2020) [1] can be applied to broad policies but also a more granular level, such as specific public interventions. Given the local nature of the public interventions, Cavalli et al. (2020) [1] is considered, by the authors, the most suitable methodology for this vertical (general to specific and vice-versa) SDGs based sustainability analysis.

Applying Cavalli et al. (2020) [1], the research presents the sustainability analysis of 1278 public interventions in a territory between four Italian regions (Marche, Umbria, Abruzzo, Lazio) — where 138 municipalities are located, and about 575,000 inhabitants reside — severely hit by earthquakes in 2016 and 2017 that devastated the areas causing deaths and massive economic damage. This study was part of the CITI4GREEN project.

CITI4GREEN was funded by EU DG REGIO Cohesion Policy 2020, which designs, implements, and promotes resource management and territorial risk mitigation interventions by reinforcing the enhancement of green actions and solutions as an optimal lever to support the rebirth of the economy and social cohesion and

to avoid the abandonment of marginal, remote and mountainous areas affected by earthquakes. The project aims at collecting data and results from the ReSTART project of the Central Apennine District Authority, intersecting it with the UN Agenda, and engaging stakeholders and shareholders for a better understanding and co-assessment. The ReSTART project framework, including coordination efforts for the entire domain of interest of the 2016-2017 earthquakes, includes the full list of public interventions designed and implemented to sustain the reconstruction of the domain. Therefore, the project aims at guiding coordinated and joint efforts of researchers, stakeholders, and citizens toward actions inspired by the principles of sustainability to promote climate resilience and environmental, social, and economic protection.

Considering the rebuilding target, the results exhibit the greater importance given by the public interventions to environmental and social factors. Nonetheless, for a more inclusive "restart," policies involving the economic development of the areas are necessary, focusing not only on the present but also on the future of the communities affected.

Finally, the studies and methodologies need a large subjective evaluation left to researchers or private operators, except for the SDGs tracker. The more institutions provide sustainability data for their interventions, the more the subjective part of methodologies can be reduced.

Laws may be necessary to make criteria for sustainability mandatory for structural interventions, public or private. Public institutions could require the following information to be public: the presence of aquifers and proximity to freshwater; details about building materials and environmental impacts of the materials used, construction methodologies, and environmental and social impacts of construction (such as workers' salaries); the state of flora and fauna in the building area: the presence of endangered species, the land use such as wooded distribution, uncultivated land, green areas, built-up percentages; cost and benefit analysis of the intervention. If this information were available, it would be easier to make assessments for researchers and taxpayers to accept public resources' expenditures.

This concern is further expanded in the discussion section at the end of the paper.

2. Materials and Methods

This research is built upon a mixed method that, as seen in the previous section, is more scalable than other models and can be applied both to broad policies and to a more granular level such as specific public interventions. For the specific case, materials and methods are respectively associated to the public interventions database (i.e. information, categories and specifications of the interventions funded by Cohesion policy funds to reconstruct the areas damaged by the earthquakes) and the methodology developed to assess the impact of such financial resources in terms of advancements towards the UN SDGs.

The public interventions database creation process initiated with the data gathering from the ReSTART study area with specific regard to the studies, projects and actions produced by the Central Apennine District Authority. This study area includes 138 small municipalities and 10 cities distributed in four regions (Lazio, Abruzzo, Marche, Umbria) identifying all administrative units that were hardly hit by the 2016-2017 earthquakes. Public interventions data were mainly gathered from the ReSTART project database and from the regional commissarial offices in charge of the procurement and execution of public reconstruction works. Public interventions include 1288 listed items distributed in the four regions as follows: Lazio: 239 interventions for 240,272,560.30 €; Abruzzo: 184 interventions for 220,420,232.20 €; Marche: 686 interventions for 945,801,421.59 €; Umbria: 179 interventions for 216,673,762.28 €. Total of 1288 interventions for 1,623,167,976.37 €.

In particular, the methodology, developed by the Eni Enrico Mattei Foundation (FEEM) in collaboration with the Autonomous Region of Sardinia (RAS) is built upon the model constructed by RAS in the Strategic Environmental Assessment (SEA) procedure of the 2014-2020 ROPs [8]. The assessment method is in line with the methodology introduced by the European Commission [6] regarding the construction of a series of matrices capable of capturing and evaluating the sustainability of the investments of the Sardinian Regional Operational Programs (ROPs), co-financed by the European Union as part of the Cohesion Policy, in terms of the 2030 Agenda 17 Sustainable Development Goals (SDGs) [1, 15, 16]. Specifically, the model studies the interconnections between the 169 targets of the 2030 Agenda and the Intervention Fields (IFs) proposed by the European Commission for the implementation of the 2021-2027 Programs specifically related to the European Structural and Investment Funds (ESIF).

The development of the model has implied six main steps (for further details see: [1, 15, 16]):

1. The correct interpretation of the targets, considering not only the textual description but also the associated global indicators [17];

2. The creation of a $169 \cdot m$ (where m is the number of investments considered) matrix populated by weights assessed considering the type of impact (0, null; 0.4, indirect; 1, direct) that each intervention field has on the individual target of the 2030 Agenda;

3. The construction of a second $169 \cdot m$ matrix populated by weights that consider the orientation (-, negative; +, positive) and the magnitude of the impacts (0.1, very low; 0.4, low; 0.7, medium; 1, high);

4. The creation of a final matrix obtained from the product of the two aforementioned matrices;

5. The production of a series of synthetic measures that capture the aggregate impact of each intervention on the individual targets and Goals and the 2030 Agenda as a whole;

6. After the calculation of the final coefficients, the multiplication of the latter by the financial resources planned for each intervention field.

In this paper, the same methodology has been implemented to evaluate the potential impact on the 2030 Agenda of the 1278 reconstruction and restoration interventions in the Abruzzo, Lazio, Marche, and Umbria regions affected by the 2016-2017 seismic events, identified in Annex 1 of the Ordinance n. 109 of December 23rd, 2020 [18]. To be exact, the analysis' geographic domain of interest includes 259 municipalities, 12 provinces, and four regions.

In order to simplify the evaluation of the investments, they have been organized into nine categories: 1) Businesses; 2) Cultural Heritage; 3) Cemeteries; 4) Hydrogeological Instability & Water Resources; 5) Construction Activities; 6) Schools; 7) Social and Health Structures; 8) Urbanization Works; 9) Other Interventions. Table 1 and Figure 1 highlight how resources are distributed by category.

Table 1. *Distribution of resources by category, number of interventions, programmed amounts, and average amounts per intervention.*

Category	**N. interventions**	**Total scheduled amount**	**Average amount per intervention**
Businesses	35	30,473,665.09€	1,410,831.56€
Cultural Heritage	186	230,024,709.93€	1,236,691.99€
Cemeteries	84	60,837,480.90€	724,255.73€
Hydrogeological Instability & Water Resources	147	149,729,271.14€	1,018,566.47€
Construction Activities	308	213,562,670.99€	693,385.30€
Schools	199	509,830,078.64€	870,676.15€
Social and Health Structures	34	95,017,658.76€	2,561,960.19€
Urbanization Works	89	52,592,858.04€	2,794,637.02€
Other Interventions	196	276,522,985.39€	590,930.99€
Total	**1278**	**1,618,591,378.88€**	**1,322,437.27€**

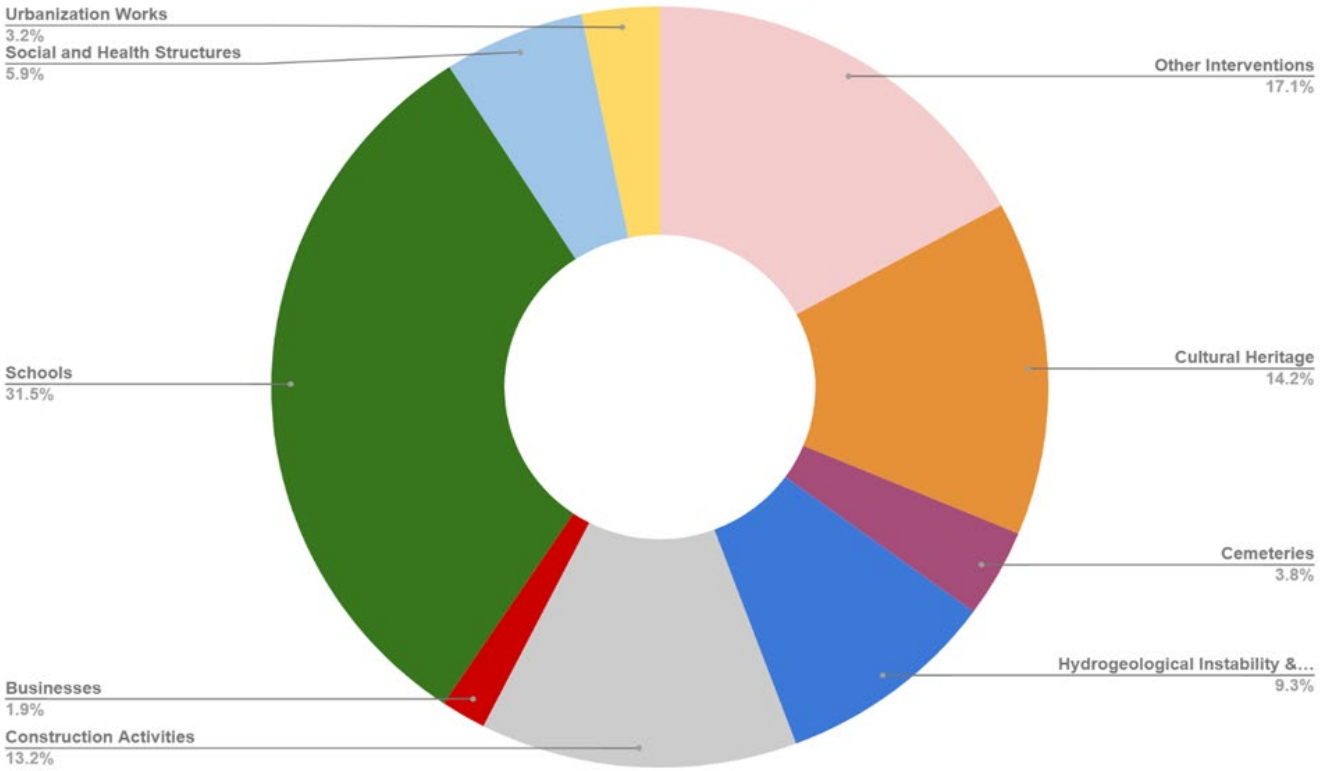

Figure 1. *(percentage) Distribution of resources by category.*

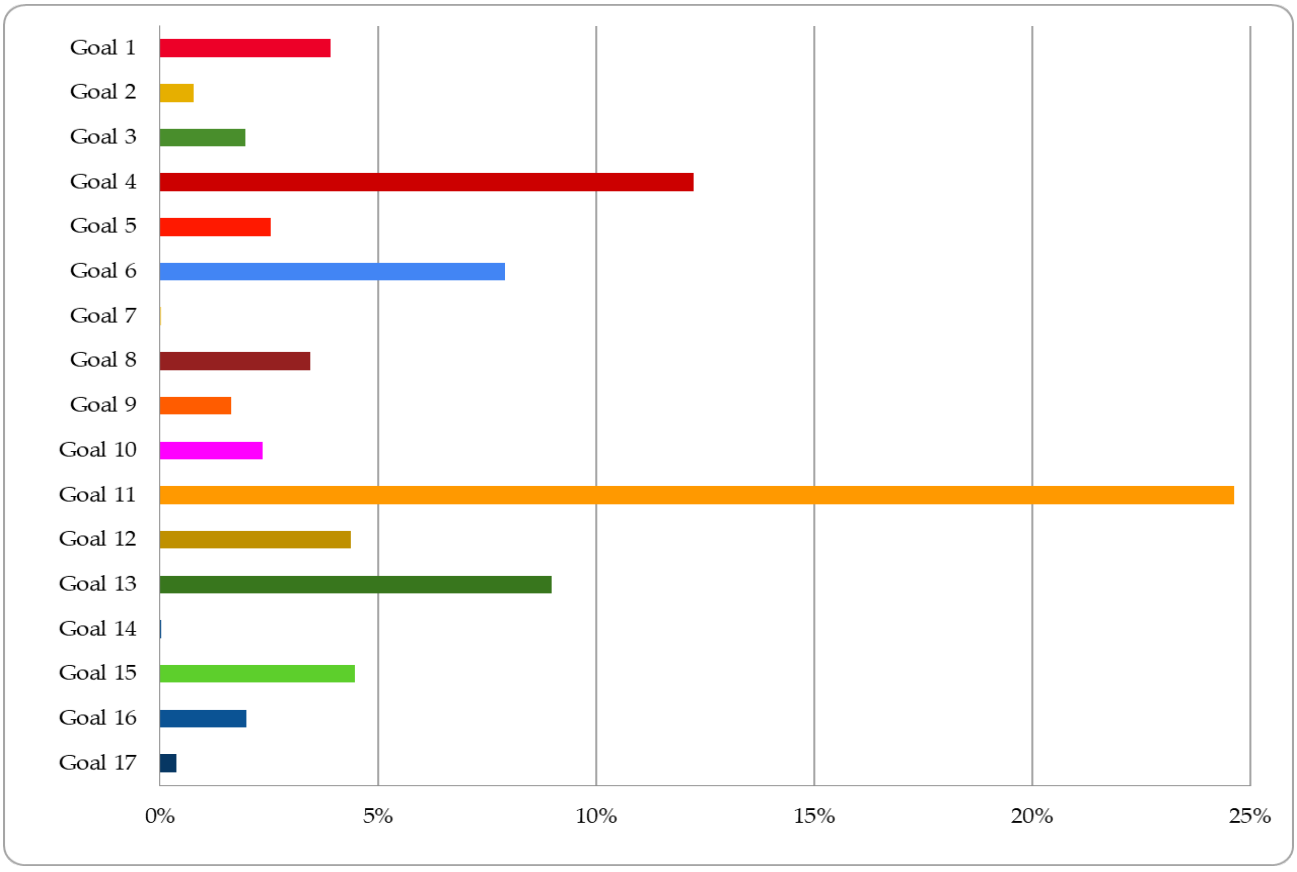

Figure 2. *Average percentage achievement per Goal, net of investments.*

3. Results

In this section, the authors examine first the impacts net of the investments, and then the results derived by multiplying the final coefficients with the programmed resources. Figure 2 above shows how, on average, the 1278 interventions affect the 2030 Agenda SDGs before involving money outlays.

It clearly emerges that the reconstruction and restoration investments in Abruzzo, Lazio, Marche, and Umbria Regions mainly contribute to Goal 11, "*Sustainable cities and communities*," which, out of 1278 interventions, has an average realization of 24.62% per intervention. This is due mainly to the Construction, Hydrogeological Instability, and Cultural Heritage related interventions that respectively impact mostly the targets 11.1 "*By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums*," and target 11.4, "*Strengthen efforts to protect and safeguard the world's cultural and natural heritage*."

In second place in terms of impact, there is Goal 4, "*Quality education*," thanks to the 199 interventions on Schools with an average achievement of Goal 4 of 12.22% per intervention in absolute terms.

Goals 13, "*Climate Action*," and 6, "*Clean water and sanitation*," follow with an average achievement of 8.98% and 7.91%. Both are driven by the category of "*Hydrogeological Instability & Water Resources*," which obtains, respectively, average achievement of 20% and 62%. In particular, the most impacted targets are 13.1, "*Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries*," 6.1, "*By 2030, achieve universal and equitable access to safe and affordable drinking water for all*," 6.4, "*By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity*," 6.6, "*By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes*," and 6.b, "*Support and strengthen the participation of local communities in improving water and sanitation management*."

In conclusion, the least impacted Goals are Goal 14, "*Life below water*," and Goal 7, "*Affordable and clean energy*." The result related to Goal 14 is not unexpected: the latter principally refers to the protection of maritime or coastal areas, while the reconstruction interventions analyzed here mainly refer to mountain areas. For what concerns Goal 7, it was surprisingly impacted by only two interventions, namely those related to the hydroelectric plants of Castel Sant'Angelo in Lazio and Arquata del Tronto in Marche.

Turning to the results derived from the multiplication of the final coefficients with the programmed financial allocations, Figure 4 presents the updated distribution of impacts on the 2030 Agenda considering the financial amounts.

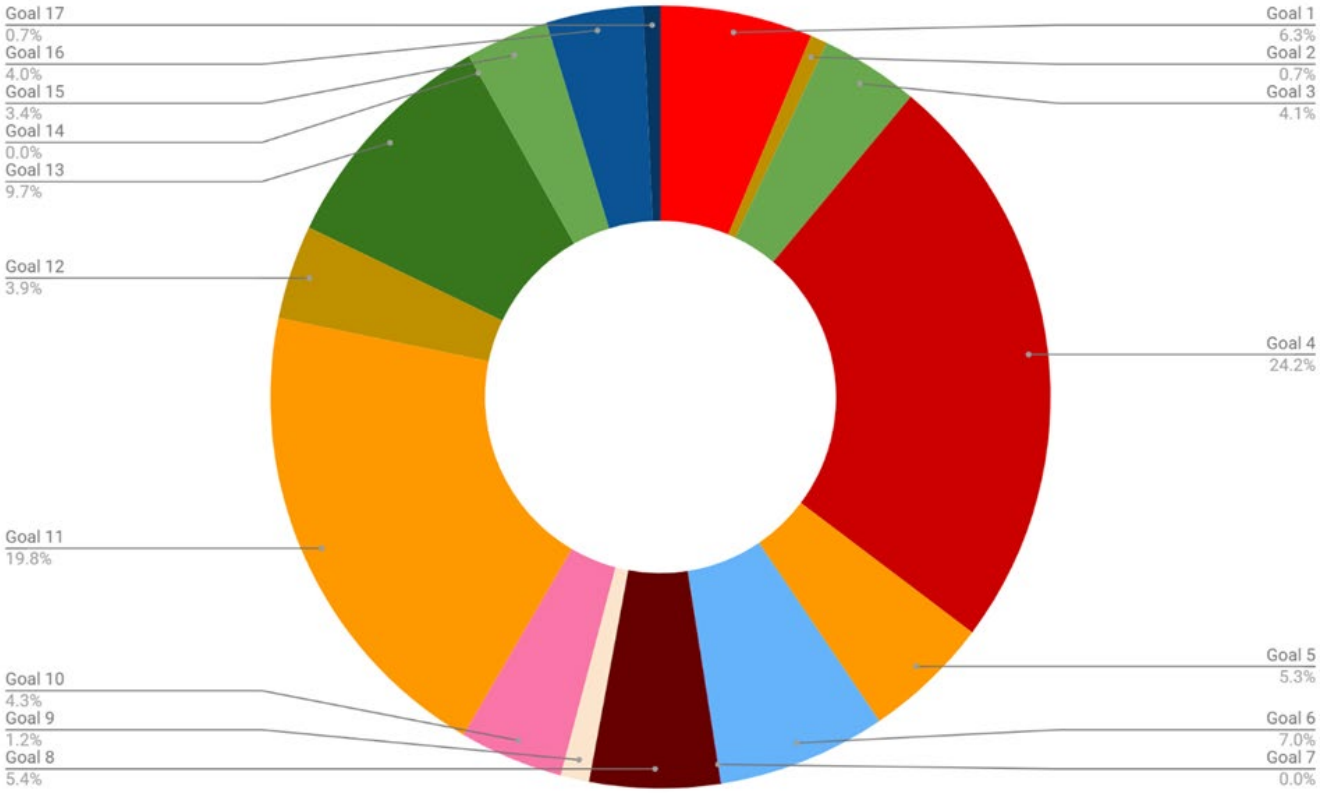

Figure 3. *The contribution of investments related to the restoration interventions on the 2030 Agenda.*

The product of the final coefficients (Point 5 of the methodology) for the financial allocations allows to concretize the distribution of resources on the Goals (i.e. the weights of the interventions on the Goals change once the amounts associated with them have been considered.)

While Goal 11, "*Sustainable cities and communities*," is at the top of the ranking in absolute terms, when the budgetary allocations are taken into account, Goal 4, "*Quality education*," is the most impacted. As shown in Table 1, Schools, the primary driver of Goal 4, receive 31.5% of the total financial allocations. As a result, Goal 4, "*Quality education*," takes first place, accounting for 24.2% of the total impacts on the 2030 Agenda. Goal 11, "*Sustainable cities and communities*," comes in second with 19.8% of total investments, followed by Goal 13, "*Climate Action*," and Goal 6, "*Clean water and sanitation*," each providing 9.7 and 7% of financial resources to the Agenda, respectively.

4. Discussion

The study features the three pillars of sustainable development — environmental, social, and economic — in the analysis.

Environmental sustainability is oriented toward the rebuilding and resilience of the natural heritage rather than focusing on the energy transition. Its main affected Goals are 13, "*Climate action*" and 6, "*Clean water and sanitation*," thanks to the interventions in "*Hydrogeological Instability & Water Resources*." Contrarily, Goals 14, "*Life below water*" and 7, "*Affordable and clean energy*," are the least affected by investments.

Schools are the most noticeable and significant interventions in social sustainability. Goal 4, "*Quality education*" — the leading Goal in achieving the 2030 Agenda [19] receives the largest financial resources than any other Goal. Goal 11, "*Sustainable cities and communities*," follows in second place thanks to Construction and Cultural Heritage investments. Both focus on (re)building essential sites for local communities such as theaters and sports centers, drivers for social cohesion and development.

Goal 8, "*Decent work and economic growth*," and, indirectly, Goal 1, "*No poverty,"* incorporate the economic dimension of sustainability. There is a clear under-representation of entrepreneurial and industrial investments compared to the other Goals. Innovation, responsible consumption and production, and sustainable tourism will need different financial instruments, sources, and other dedicated policies to embrace the whole community and ensure more integrated sustainable development.

To conclude, we highlight the importance of developing strategies to coordinate the policies and tools to identify, integrate, implement and achieve the Sustainable Development Goals of the 2030 Agenda. Rebuilding is not just restoring. The Agenda offers a guide for the transition toward a more resilient, green, and inclusive society, prepared for present and future challenges.

Limits of the research and open issues

In the data science community, a famous motto paraphrases into "your model's output is only as good as your data input." Environmental sciences would significantly benefit from more and better inputs. It would help researchers, public institutions, and, ultimately, the public. This research highlights the necessity for an immediate increase in the information regarding public intervention. General assessments can be only as good as the data provided by the government. In the meantime, qualitative-quantitative methods, such as Cavalli et al. (2020) [1], are the best tools available to serve as a transition methodology. This paper is a real-world example that fills the gaps in both the literature and practical applications.

Researchers applied Cavalli et al. (2020) [1] to the mentioned 1278 public interventions using the publicly available information released by the Italian government. The authors know that a more thorough analysis could have been performed by selecting a slice of these interventions and analyzing them more in detail by

physically visiting the construction sites. However, one of the purposes of the paper is to highlight how deep research and assessments of public works can go using the information at public disposal. Moreover, exploring in-depth even a portion of the construction sites would have required a significantly larger investment either for transportation and accommodation or for the necessary recruitment of experts such as construction engineers. As crucial as sustainability is, researchers visiting every construction site is inefficient and impractical. This calls for an urgent synergy between research and public institutions, starting with more data collection and sharing by the government.

Besides helping researchers produce more accurate cost-benefit reports and sustainability assessments, increased transparency is likely to generate positive externalities such as an increment of trust in public institutions. Furthermore, increased control by research institutions could help diminish fraud against taxpayers.

Governments should connect the SDGs to their national and subnational budget systems [20]. In this regard, building and utilizing a complementary and scalable financial tracking tool linked to the 2030 Agenda, capable of determining *ex-ante* how much of the total spending goes toward achieving SDG targets while also allowing for *ex-post* monitoring of the impacts per unit of funding, becomes fundamental [21].

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