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Local Governance Support Tools for Disaster Risk Reduction and Climate Adaptation Strategies: The EU Contribution in the Case Study of the Municipality of Naples

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Abstract: Today's global context poses ongoing challenges that can be addressed by implementing a systemic and strategic approach directed toward climate-resilient cities. During times of energy and digital transition, managing climate risks involves analysing sector-specific impacts and fostering a shared commitment at the national and international levels; in this sense, European programs promote the dissemination of good practices and implementation of projects and tools to improve the resilience of communities to climate challenges. This paper examines the Naples municipality as a case study within the SEACAP 4 SDG capitalization project in the implementation of innovative governance support tools for hazard and climate adaptation, mitigation, and energy rehabilitation to enhance local governance, planning, and design strategies towards a sustainable and low-emission future. Within the creation of a living lab, tools were selected as part of the project, and training sessions were held targeting key stakeholders. The training aimed to form and inform key players about the tools' potential, leading to their incorporation into the municipality's strategic action plan for future implementation. This case study has a high repeatability and stands as a starting point for the implementation of this approach in numerous other local municipalities.

Keywords: governance; induced risk; soft-resilience tools; living labs

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1. Introduction

From the disaster risk reduction (DRR) perspective, disaster risk is defined as "the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time" [1]. This is in line with risk as considered in the context of climate change adaptation (CCA), defined as "the potential for adverse consequences for human or ecological systems, recognizing the diversity of values and objectives associated with such systems" [2]. Both DRR and CCA assess risk, enhance capacities, reduce vulnerabilities and exposure, and strengthen resilience. Synergies can be harnessed across sectors and at different governance levels with multiple stakeholders' efforts and have to be context-specific [3]. In the context of climate change, the European Green Deal (EGD) [4] and the European Adaptation Strategy [5] are two key initiatives of the European Union (EU) that address climate change within a climate-resilient development context [6], in line with the objectives of the EU Action Plan [7] on the Sendai Framework for DRR [8], a concept and practice of integrating climate mitigation and climate change adaptation measures into the planning, design, and implementation of development initiatives. It aims to enhance the ability of societies, ecosystems, and economies to withstand and recover from the impacts of climate change while achieving Sustainable Development Goals (SDGs). According to Eurostat, buildings are responsible for about 40% of the EU's total energy consumption and for 36% of its greenhouse gas emissions from

energy, and almost 50% of the EU's final energy consumption is attributed to heating and cooling, of which 80% is allocated to buildings [9]. Improving energy efficiency in buildings is crucial to attain the EGD's ambitious goal of achieving a 55% reduction in emissions. By the year 2030, the EU must work diligently to decrease greenhouse gas emissions from buildings by 60%, curtail their final energy consumption by 14%, and notably cut down energy consumption for heating and cooling by 18%. The Commission recommendation (EU) 2019/786 [10] encourages local public authorities, regions, and municipalities to proactively assess the energy performance of their public building stock, identify areas for improvement, and develop strategies to achieve energy efficiency goals. Implementing energy efficiency retrofitting plans involves upgrading insulation, optimizing heating and cooling systems, installing energy-efficient lighting, and utilizing renewable energy sources where possible. These measures help reduce energy consumption and decrease greenhouse gas emissions and footprint but also lower operating costs in the long term. These plans can include timelines, targets, and financing mechanisms to support the implementation of retrofitting measures. Member states are encouraged to develop and implement these long-term renovation strategies, considering factors such as building typologies, local climate impact context, and socio-economic aspects.

According to the literature, integrated adaptation and mitigation are considered particularly important at the city scale [11]. In urban areas, efforts to address climate change involve creating and putting into action policies and practices aimed at lessening human-caused greenhouse gas emissions, commonly referred to as mitigation measures. These measures primarily target emissions from energy production, land use, waste, industry, infrastructure in the built environment, and transportation [11]. Adaptation measures in response to climate-related impacts and risk involve adjusting the built, social, and ecological environment to decrease the adverse effects of gradual and extreme events resulting from climate change. These measures include innovative approaches to rehabilitate the built environment [12]. Furthermore, climate adaptation and environmental resilience policies in coastal cities such as those of the Mediterranean basin should not compromise human rights, justice, equity, poverty reduction, social inclusion, and redistribution [13].

The intensity and impact of climate change-induced extreme weather events in cities are determined by the local characteristics of the built environment. Already characterized by high levels of exposure and vulnerability, cities represent the main field of experimentation for innovative and climate-resilient design principles and methods [13,14]. In this sense, the connections between DRR and CCA strategies have started to reshape how researchers and practitioners perceive and tackle the assessment and control of urban climate risks, their related effects, and response actions [15]. Both disciplines have a shared objective: minimizing the effects of extreme events and enhancing urban resilience against disasters; furthermore, they share a common understanding of the components of vulnerability, the processes of building resilience to exposure conditions and magnitude of hazards and an interplay between policy action and specific design/technical solutions in response to local priorities [16]. The concept of vulnerability is defined here as "susceptibility to harm" of a given "exposed element" (people, assets, ecosystems) under the effect of a given hazard (be it rapid- or slow-onset). In other words, vulnerability represents "the propensity or predisposition to be adversely affected" [15,17,18]. It is a key aspect in DRR and CCA. Indeed, conducting vulnerability assessments, implementing hazard mitigation measures, and having efficient emergency management plans can help decrease impacts and support recovery efforts. DRR and CCA synergies encompass a comprehensive, holistic approach that evaluates trade-offs, the combined advantages of integrated mitigation and adaptation measures (co-benefits), and shared pathways and management strategies for enhancing resilience [14]. CCA and DRR use a multi-sectoral approach (risk and climate science, urban, social, and ecological studies, regulations, and technical solutions) and a multi-scale resilient design approach (region, city, district, building) [19]. Effective DRR/CCA strategies in cities are grounded on the interplay between policy action and specific design/technical solutions in response to local priorities. They necessitate that designers expand their ex-

pertise into a multidisciplinary and multi-scale dimension [14]. Recurrent methodologies are designed to support cities in raising awareness about the impact of climate change and undertaking mitigation and adaptation activities to support decision-making processes.

Based on these assumptions, it appears essential that the actions implemented actively focus on the involvement of all the actors involved, proposing development and implementation activities that promote the efficiency of the built environment and the territory and the dialogue between technicians, administrations, and citizens.

This contribution presents the case study of the city of Naples developed within the European project SEACAP 4 SDG [20]. This study takes place in Mediterranean territorial cooperation projects, where academics, local stakeholders and decision-makers work together through regional cooperation initiatives to tackle common challenges such as energy management, water resource management, environmental protection, economic development, and climate change resilience. Through the Naples case study, the research focuses on the integration of energy efficiency and sustainable building practices in urban planning processes, by considering energy performance in the overall urban development and design, to promote the creation of sustainable, low-carbon, and climate-resilient cities and communities in a multi-hazard context.

The aim of the research is to introduce the methodology and tools developed within European funded projects aimed at supporting the implementation of the Sustainable Energy and Climate Action Plan (SECAP) for the Municipality of Naples, a local climate action plan that is developed within international urban climate networks such as Covenant of Mayors. The Naples SECAP aims at identifying urban governance, planning and design strategies able to integrate climate adaptation and mitigation goals. Previous and ongoing joint activities carried out by the Municipality of Naples, PLINIVS-LUPT Study Centre of University of Naples Federico II and ANEA within EU-funded projects provided an initial understanding of climate risks and vulnerabilities, the baseline emission inventory and a review of current and planned urban projects and initiatives to identify their potential benefits in terms of climate adaptation and mitigation. The joint efforts of academics and the municipality in leading activities bring specialized technical knowledge, which represents a valuable resource for implementing inclusive strategies to manage risks. The paper aims to raise society's awareness regarding disasters and the available local management options. Given the escalating frequency of disasters, the topic is both pertinent and urgent. The paper introduces innovative governance support tools and techniques to effectively tackle these disasters.

2. Materials and Methods

This section first provides a brief introduction to the SEACAP 4 SDG project and its aims and then delves into the multi-risk context of the city of Naples related with other project experiences. An illustration of the tools proposed by the SEACAP 4 SDG project is presented together with those selected to be implemented through training activities for the municipality of Naples. A description of the methodology used to carry out the project activities is provided as well as the stakeholders involved in the study pursuing the objective of implementing the strategic plan.

2.1. European Projects for the Mediterranean Basin: SEACAP 4 SDG

The European Project "Med SE(A)CAP integration through uniform adapted assessment and financing methods, mainly targeting buildings in education and health sectors, for sustainable development goals in a smart society"—SEACAP 4 SDG, is a project financed under the ENI CBC MED programme which aims at environmental protection, adaptation and mitigation of climate change and thus to address common challenges in the environment through innovative and cost-effective energy efficiency actions according to different types of buildings and climatic zones, with a special focus on public buildings, thereby contributing in the effort to deal with climate change by reducing energy consumption in public buildings, promoting the development of SE(A)CAP through an innovative

financial mechanism and capitalization process. The initial project duration was 18 months with an extension of a further 6 months with the involvement of France, Egypt, Greece, Italy, Jordan, Lebanon, Spain, and Tunisia as partner countries.

The project belongs to the capitalization projects; in fact, it selects best practices from different European projects and takes care of their implementation and promotion. The tools selected by the entire project come from:

- ENI CBC MED program:
  - MED-DESIRE: Mediterranean Development of Support schemes for solar Initiatives and Renewable Energies.
  - BEEP: BIM for Energy Efficiency in the Public sector.
  - BERLIN: Cost-effective rehabilitation of public buildings into smart and resilient nano-grids using storage.
  - ESMES: Energy Smart Mediterranean Schools Network.
  - GreenBuilding: Minimising Energy Consumption for Green Buildings respecting present uses and public needs.
  - Med-EcoSuRe: Mediterranean University as Catalyst for Eco-Sustainable Renovation.
- Interreg Med program:
  - EduFootprint: School low carbon footprint in Mediterranean Cities.
  - Impulse: Integrated Management Support for Energy Efficiency in Mediterranean PUblic buiLdings.
  - PrioritEE: Prioritise Energy Efficiency in Public Buildings—a decision-support tool for local and regional authorities.
  - SISMA: Supporting Innovative Schemes in the MED Area.
  - STEPPING: Supporting The Energy Performance Contract Public Procurement IN Going-beyond.
- Union for the Mediterranean:
  - meetMED: Mitigation Enabling Energy Transition in the Mediterranean region.
  - Clima-Med: Acting for Climate in the South Mediterranean.
  - SPREF: SEMed Private Renewable Energy Framework.

These tools were selected to develop a toolkit and complement the Sustainable Energy Access and Climate Action Plans SE(A)CAP specifically with the implementation applied to selected cities and in 4 public buildings in climate zones (Egypt, Jordan, Lebanon, Tunisia), supporting 4 cost-effective energy renovations. The project also aims to identify cost-effective approaches for energy renovation and use of public buildings, promoting ecological development (traditional use/social role), and producing short/long-term impacts on existing policy frameworks according to Sustainable Development Goals (SDGs) agreements. During the course of the project, external experts were trained on the potential of these tools; the same experts then became the trainers of technicians and stakeholders for the various selected municipalities, such as the one in Aigialeia [21] or the one in Naples that is presented in this paper, promoting the dissemination, knowledge and implementation of the strategic plans.

Mediterranean cities face common structural challenges in terms of urban development and policies, strategies, legislation, implementation, monitoring, and the reviews needed to address them [22–24]. Indeed, the Mediterranean region is characterized by one of the fastest rates of urbanization in the world, with almost 60% of the population already living in urban areas; the development of large cities has led to the decline of many historic city centres, thus endangering the cultural heritage of Mediterranean civilizations, Mediterranean landscapes and the irreplaceable identity of the Mediterranean region; the growth prospects of Mediterranean cities only foreshadow a worsening of already worrying current problems: excessive land consumption (artificialization of soils, irreversible loss of arable land; accelerated degradation of the built cultural heritage; pollution of groundwater; inefficient waste management; and the cumulative effects of all these factors on the envi-

ronment and the health of the populations [22]. To this end, the institutions have called for a regional response with capacities, tools, and resources to assist Member States and their local authorities with the involvement of other relevant stakeholders, in line with national policies and legislation, as an effective mechanism for urban planning and sustainable urban development. Adaptation and mitigation plans in European cities are at an early stage, and only a handful of Mediterranean cities have local climate plans that incorporate both mitigation and adaptation strategies collectively [22,23]. In the Mediterranean region, local stakeholders face specific limits and barriers when implementing adaptation measures to climate change for urban resilient cities and renovation strategies. Mediterranean countries often experience hot and dry summers, which pose challenges for energy-efficient renovations. Cooling demands in buildings can be high, requiring effective insulation, shading systems, and efficient cooling measures for adaptation to climate change. Patrimonial and architectural heritage present a constraint: many Mediterranean countries have a rich cultural and architectural heritage, with buildings that are historically significant [24]. Renovation strategies must carefully balance energy efficiency goals with the preservation of architectural heritage, which may require specialized expertise and techniques. Meeting modern energy efficiency standards with patrimonial value can be more challenging and costly compared to newer constructions. Collaboration and communication challenges can arise, requiring efforts to facilitate partnerships and ensure smooth implementation. In this realm, community and institutional coordination hold a pivotal position [25]. Therefore, urban services are seen to be aimed at increasing the capacity of society, cities and infrastructures to be able to adapt to climate change—taking knowledge from climate services and translating it into concrete services and solutions [26]. Resilient cities require a robust and efficient risk governance framework that fosters interdisciplinary collaboration and maintains connections among policy experts, technical services, and urban designers. Prioritizing knowledge-based decision-making and science-driven strategies ensures effective coordination and cohesion.

For these reasons, starting with the objectives of the SEACAP 4 SDG project and the proposed tools, the goal of the SEACAP 4 SDG training for the City of Naples is to integrate relevant tools proposed by the project within the methodological workflow already defined by the Technical Department "Environmental monitoring and SEAP implementation" for the upgrade of the current Naples SEAP into SECAP.

To support the city of Naples in raising awareness of the impacts of climate change and undertaking mitigation and adaptation measures, and support decision-making processes, the following European research project, in addition to requiring particular attention to methodological developments, monitoring and indicator studies, predictive modelling, quantification of the impacts of extreme weather events, scenario development, economic costing, integrated assessment, modification of existing coping strategies, testing and evaluation of adaptation measures, also focuses on stakeholder involvement and participation.

2.2. Naples as a Multi-Risk Context

2.2.1. Naples Climate Change Profile

Naples, as various Mediterranean urban areas in Europe, has already faced significant climatic variation in recent years with respect to the "historical" reference period 1971–2001 (bias-corrected EURO-CORDEX data) [27,28]. In recent years, there has been a consistent rise in both minimum and maximum temperatures, linked to more frequent occurrences of heatwaves, with seasonal precipitation patterns exhibiting a noticeable shift between periods of drought and extreme events characterized by intense rainfall concentrated in a few hours, responsible for surface flooding. Simulations available for future scenarios (up to 2100) confirm these trends, despite uncertainties about the severity of projected climate change caused by diverse greenhouse gas emission scenarios on a global level (Figure 1) [27].

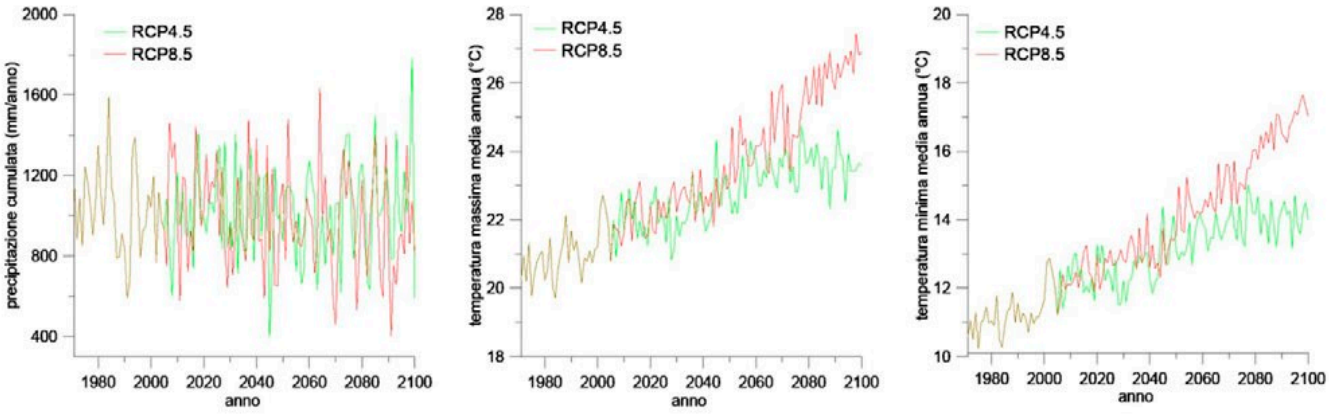


Figure 1. Annual averages over the period 1971–2000 of precipitation and air temperature for the city of Naples. For the period 1971–2000, the annual values of cumulative precipitation (**left**), average maximum temperature (**centre**) and minimum temperature (**right**) are elaborated from the Capodichino station; for the period 1971–2005, the models are forced through observational datasets (20C3M) while for 2006–2100 the RCP4.5 (green) and RCP8.5 (red) concentration scenarios are considered. Source: CMCC—Euro-Mediterranean Climate Centre.

However, annual average values compiled using statistical methods from observations at individual weather stations do not allow for the representation of the critical issues that cities face with regard to climate change. There is a need for more precise information on the frequency of extreme temperature and precipitation events and for consideration of how the impacts of these extreme events can be exacerbated by specific urban characteristics, such as the urban heat island effect and surface runoff conditions.

In the selection of the SEACAP 4 SDG's tools to be applied to the case of Naples, the results of the CLARITY project [27] have been taken into account, focusing on defining these factors, identifying the rise in the frequency of heatwaves and extreme rainfall events until 2100, as well as the creation of precise urban morphology and land-use models to understand how built environment elements influence the urban microclimate. The CLARITY tools, which aid in design and decision-making from a multi-risk standpoint, can serve as a crucial asset in enhancing the application of scientific findings by decision-makers and designers across different levels. These tools are aimed at fostering the development of efficient strategies that integrate national to local disaster risk reduction (DRR) and climate change adaptation (CCA) policies. The utilization of various datasets processed with simulation models created by the PLINIVS-LUPT Research Centre for CLARITY enables the determination of forecasted hazard levels associated with heatwaves and surface flooding (Figure 2). The heatwaves data analysis in the CLARITY project indicates that events similar to those observed in recent years, such as prolonged periods of 36 °C temperatures lasting more than 6 consecutive days, will experience a substantial increase in both frequency and intensity over the next thirty years. Additionally, these extreme events are projected to reach intensity levels that have never been recorded before, with periods exceeding 9 consecutive days of temperatures above 38 °C. Furthermore, the analysis of surface flooding data reveals that flood events resembling those observed in recent years will undergo a substantial rise in frequency and intensity during the next thirty years. This upward trend is projected to continue, with flood levels reaching unprecedented magnitudes of up to 100 mm per day in the latter half of the century. This information serves as the foundation for corresponding impact models, which help identify the consequences of heatwaves on the population, such as impacts on human health and increased mortality, the energy needs variation (Figure 3) and the effects of flooding on buildings, including disruptions to networks.

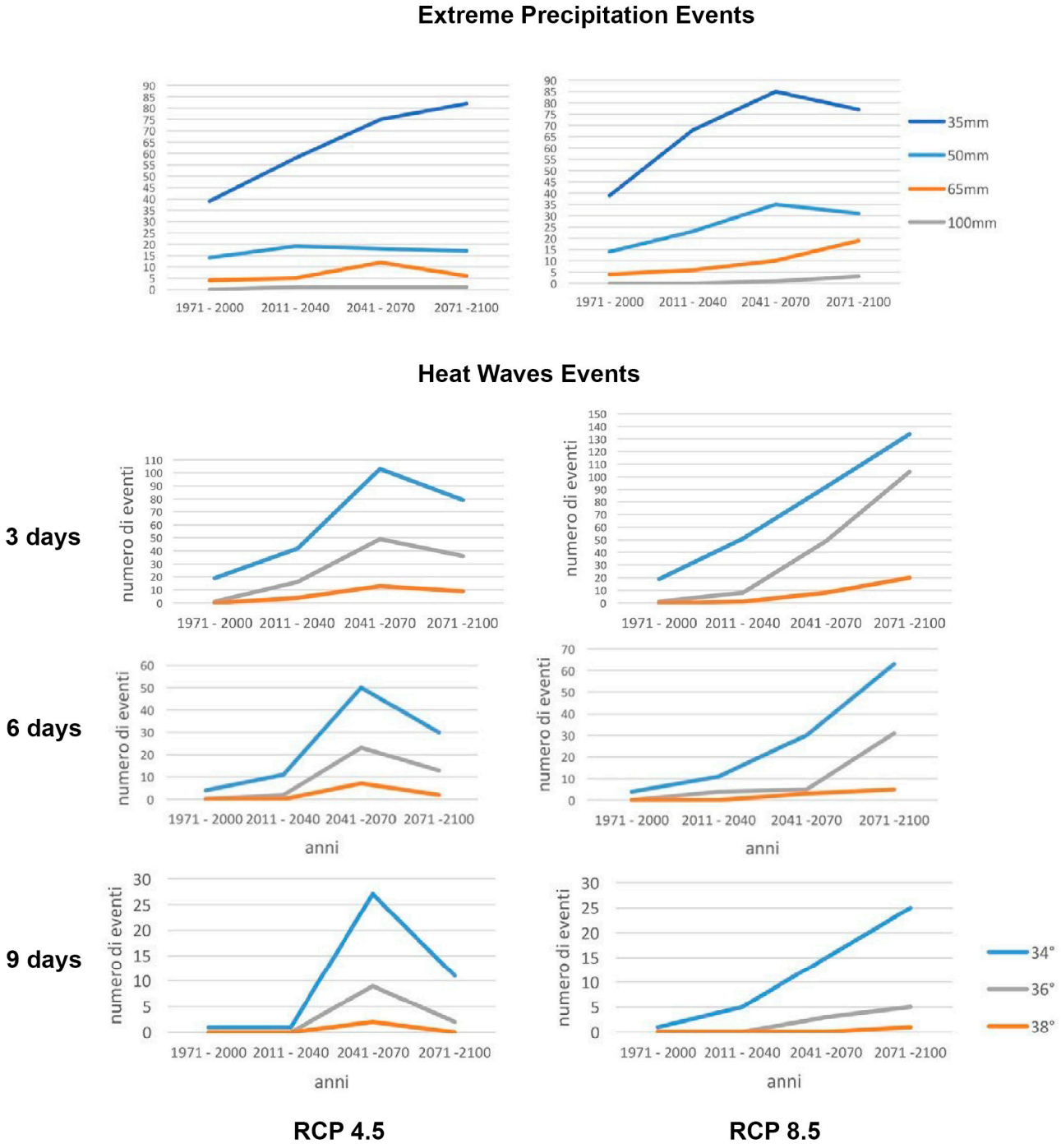
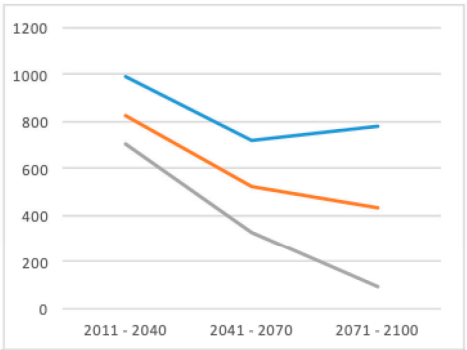
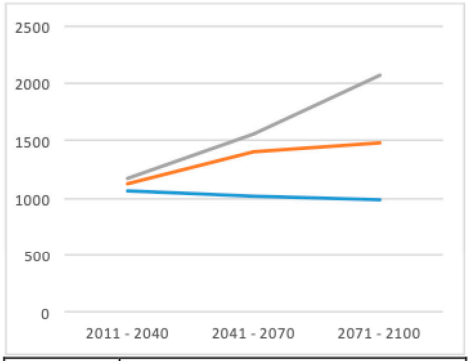


Figure 2. Extreme events of temperature and precipitation in Naples (Source: [27]).

In addition to heat waves and pluvial floods, the city of Naples is also prone to coastal flooding, which has an impact on infrastructure (due to the combined effect of sea level rise, storm surges and heavy rainfall). The main impacts and effects are damage to buildings and open spaces in coastal areas, disruption of land and sea transport infrastructure, disruption of sub-services (electricity, sewage), and economic losses (tourism, services) [29]. The coastal flood hazard/impact assessment is currently being developed within the KNOWING project.





HDD	historical 1970 – 2000: 1389		
	2011–2040	**2041–2070**	**2071–2100**
RCP 2.6	987	714	780
RCP 4.5	827	521	432
RCP 8.5	702	323	93

CDD	historical 1970 – 2000: 772		
	2011–2040	**2041–2070**	**2071–2100**
RCP 2.6	1057	1014	990
RCP 4.5	1128	1405	1476
RCP 8.5	1168	1551	2065

	2011–2040	2041–2070	2071–2100
Variation of heating needs in Napoli area during cold spells			
RCP 4.5	−4%	−35%	−46%
RCP 8.5	−13%	−60%	−89%
Variation of cooling needs in Napoli area during heat waves			
RCP 4.5	+22%	+38%	+41%
RCP 8.5	+25%	+43%	+58%

Low uncertainty	Medium uncertainty	High uncertainty

Climate Adaptation - Temperature extremes and energy needs variation

Figure 3. Seasonal temperature variation and heating/cooling needs in Naples (Source: [27]). The colours represent the degree of uncertainty of the projection: low uncertainty (green), medium uncertainty (yellow) and hight uncertainty (red).

2.2.2. Vulnerability Assessment

The growing influence of disaster risks associated with a range of natural hazards, including those stemming from geological factors and climate change, highlights the need for enhancing existing approaches to multi-hazard risk management and mitigation. This necessitates adopting comprehensive resilience-based strategies to address these challenges. The Municipality of Naples has indicated that in the Naples SECAP, the Risk and Vulnerability Assessment, defined in the Joint Research Centre (JRC) guidelines as "expected weather and climate events of particular relevance for the local authority or region", should be compliant with the methodology of the H2020 CLARITY project, selected as an appropriate approach to guide climate change adaptation and mitigation measures, as well as to bridge the SECAP with other relevant risk planning tools at regional or metropolitan city levels, in the perspective of an integrated multi-risk approach underpinning local urban governance.

According to the JRC, the "Risk and Vulnerability Assessment (RVA) methodology determines the nature and extent of a risk by analysing the potential hazards and assessing the vulnerability that could pose a potential threat or damage to people, property, livelihoods and the environment on which they depend". In the Risk Assessment Framework proposed for the Naples SECAP (Figure 4), vulnerability is the extent of expected damage to a particular risk element or group of elements caused by the impact of a hazard with a specific intensity. It varies for each combination of hazard and risk element and is typically indicated on a "damage scale" ranging from "no damage" to "total damage". Vulnerability

assessment primarily entails identifying all elements susceptible to a specific hazard. The ability to establish precise quantitative vulnerability indicators relies significantly on data availability to organize exposure information into reliable and consistent "vulnerability classes". Vulnerability analysis methods may, therefore, change depending on data availability and resolution, leading to notable differences associated with the spatial scale of the analysis (global, national, regional, local). For example, identifying building typologies at the international level would necessitate harmonizing various national and regional datasets, where available. However, these datasets, such as those derived from ISTAT in Italy, are generally less precise and reliable compared to locally constructed datasets acquired through on-site surveys, which are only feasible within limited spatial areas. Certainly, the increased availability of data from satellite mapping, remote sensing, and IT tools plays a significant role and is innovatively utilized in the CLARITY methodology, leading to a substantial impact on updating vulnerability analysis methodologies.

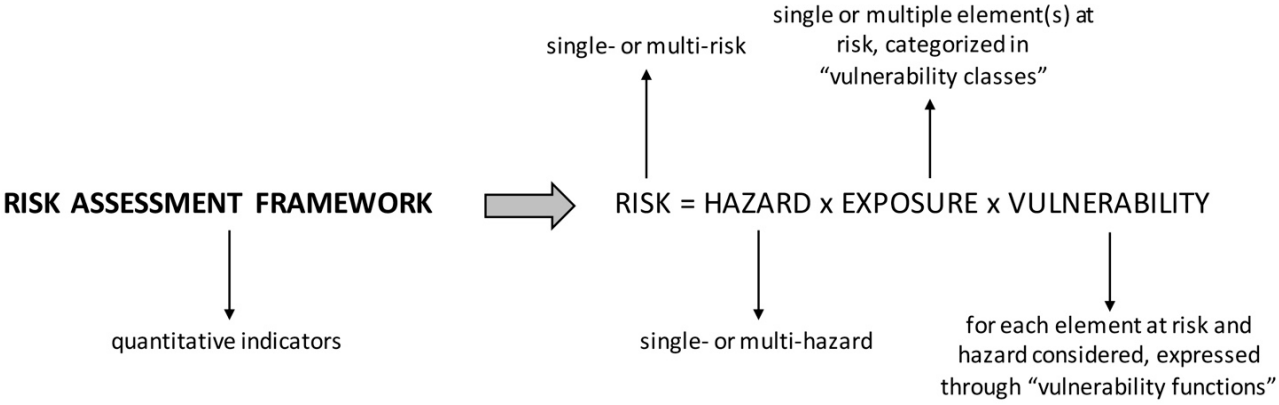


Figure 4. Consolidated approach for disaster risk assessment in the field of geophysical hazards (UNDRO, 1980, updated by the UNDRR 2017 Terminology), harmonized in the context of climate change (source: [15,17]), compatible with the CLARITY methodology, as defined for the Naples SECAP (Source: [27]).

In the Naples SECAP, the evaluation of vulnerability relies on JRC guidelines, which organize the indicators into two main categories: "Socio-economic vulnerability" and "Physical and environmental vulnerability". Vulnerability, in this context, refers to the likelihood a risk element, belonging to a vulnerability class, will experience a certain level of damage, based on a predefined damage scale, when confronted with a hazard event of a particular intensity. It is expressed through a vulnerability matrix that indicates, for each group of elements at risk, the percentage belonging to each vulnerability class with reference to the hazard investigated in the area considered.

To adhere to the JRC guidelines, the SECAP model necessitates the inclusion of vulnerability indicators as specified in the SECAP model (section "Vulnerability of the local authority or region") and all pertinent parameters concerning the assessment of the exposure of vulnerable elements to risk, including local impacts of heatwaves and flooding, as essential variables falling under both "Socio-economic" and "Physical-environmental" categories. It is important to emphasize that this addition does not alter the RVA methodology utilized, as it remains rooted in the CLARITY approach. In this sense, the project CO-FRAME_NA—Comprehensive multi-hazard & multi-risk Framework Naples is part of the broader CO-FRAME project, presented in 2020 by a variegated consortium of promoters (i.e., universities, research centres, local authorities and SMEs) within the HORIZON 2020 European call LC-CLA-16-2020—Multi-Hazard risk management for risk-based decision-making in the EU. The coordination of the macro-project was carried out by the University of Naples Federico II, in this case by the PLINIVS Study Centre (LUPT), which was able to involve partners from different European countries, with the aim of developing an integrated and multidisciplinary methodological framework for the management of natural risks

from a "multi-hazard"/"multi-risk" perspective. Improving risk governance approaches at the local level, the project's main objective was to enhance horizontal coordination and break down existing silos in governmental institutions dedicated to DRR and CCA. By emphasizing community involvement and employing multi-stakeholder engagement mechanisms, the project facilitated the sharing of knowledge across relevant sectors like security, environment, climate, economy, etc. This approach added value to risk prevention and management, aligning with the goals of the EU Action Plan on the Sendai Framework for DRR.

2.2.3. Multi-Risk Governance Framework

The objectives pursued by the CO-FRAME_NA sub-project are several. Firstly, it attempted to develop a methodological framework to carry out "multi-hazard"/"multi-risk" assessments and analyses in a harmonized approach (starting from validated methods and models) and in line with European policies. Moreover, the CO-FRAME_NA sought to develop guidelines for risk managers and planners to incorporate the new framework and tools to design concrete policy and risk governance actions through the project structure (Figure 5), in order to:

- identify practical actions to incorporate multi-risk assessments as core elements of effective risk governance (short- to mid-term actions) and sustainable and resilient development pathways (mid- to long-term actions);
- incorporate the knowledge of expected impacts and the effects of DRR and CCA measures into local plans (including sectoral plans, indications for designers, entrepreneurs and end-users), thus enhancing risk-informed decisions on, e.g., land-use planning, building reconstruction, build back better, nature-based/hybrid solutions, etc.;
- highlight the appropriate information to raise awareness and empower community-based organizations and NGOs to successfully engage in local resilience policy implementation.

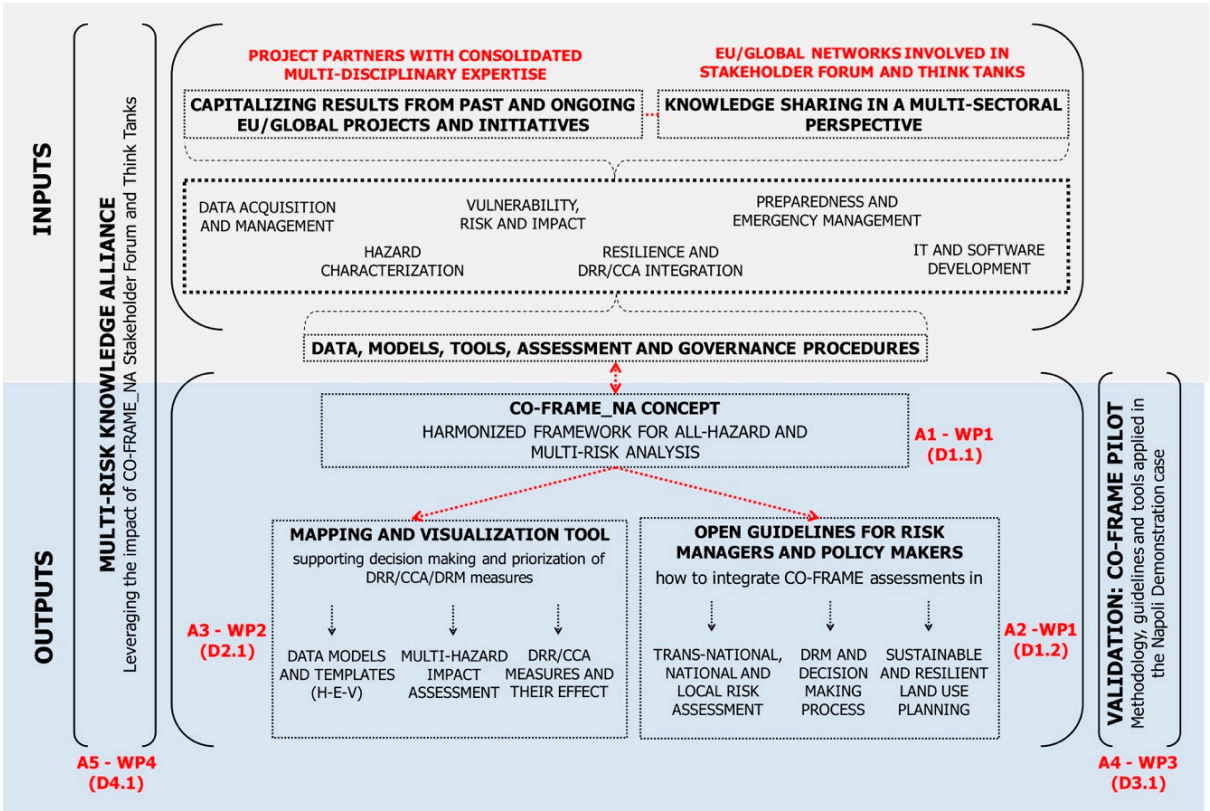


Figure 5. CO-FRAME_NA project structure.

CO-FRAME addresses a need for a cost-effective approach to disaster risk reduction (DRR) and climate change adaptation (CCA) measures that integrates multi-hazard, multi-risk assessments and governance based on reliable analyses and simulations. The result of this approach are evidence-based and robust actionable information for diverse decision makers along the DRM cycle (prevention, preparedness, response and recovery). This implies the need for coupling robust quantitative methods for risk assessment presented above (Figure 4) with a decision-support oriented risk governance framework, aiming at improving resilience and informing DRM decision-making processes (Figure 6).

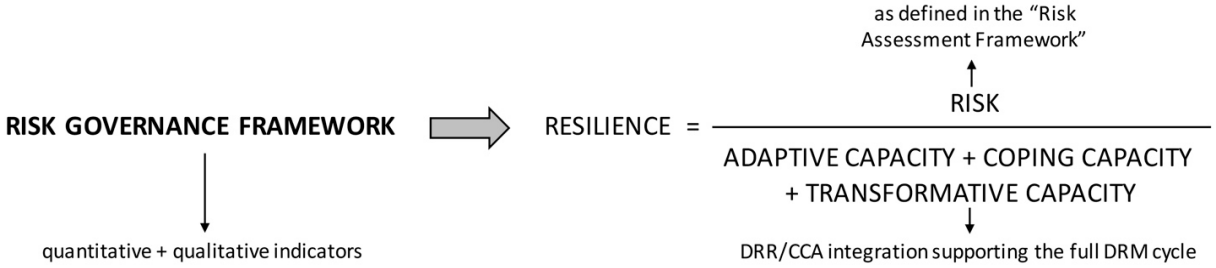


Figure 6. Risk governance framework to support the full DRM cycle and support sustainable and resilient development pathways (Source: [17]).

From the risk governance point of view, effectively tackling multi-risk along the full DRM cycle requires a comprehensive, integrated and across-scales governance approach that frames resilience in relation to the understanding of risks and adaptive, coping, and transformative capacities of a territory. This implies complementing quantitative risk assessments with qualitative indicators describing the features of DRR/CCA/DRM measures in place, to fully capture the resilience potential of a given geographical area.

The approaches utilized for engaging stakeholders rely on established methods and tools like structured interviews, focus groups, and workshops that include local administrations, neighbourhood associations, and residents. The aim is to collaboratively identify and understand the key challenges faced by the urban system concerning environmental, functional-spatial, and socio-economic aspects. This process fosters a shared understanding among all involved parties [30].

This a crucial approach to upgrading the current Naples SEAP into SECAP. The methodology is reused both in SEACAP 4 SDGs Living lab and in KKNOWING project events, to identify clear roles for the various DRR and CCA actors and stakeholders, to obtain accurate and up-to-date data and information on weather patterns, natural hazards, and vulnerable communities from expert partners, to implement comprehensive and accurate strategies, to involve the active participation and engagement of communities, define current strategies and planning in course, mapping existing overlaps, understand existing and future issues for the climate-resilient-development of Naples, to generate coordination and collaboration across multiple sectors and stakeholders, including government agencies, NGOs, private sector organizations, and communities, and to avert a duplication of efforts, inefficiencies, and missed opportunities for collaboration.

3. Results and Discussion

3.1. Results of the Assessment of Tools for Public Buildings' Energy Efficiency from SEACAP 4 SDG's Toolkit

The ENI CBC MED's SEACAP 4 SDG project [20], as mentioned above, presents a list of primary tools and methods that can be suggested to Mediterranean cities to enhance their energy efficiency plans, coming from financed projects in different EU programs and initiatives. As a local expert for the municipality of Naples, PLINIVS-LUPT Study Centre of University of Naples Federico II and ANEA followed targeted training sessions, where efforts were made to assess the necessary actions for advancing long-term energy plans, implementing measures to enhance building energy efficiency, achieving energy

savings, and promoting the adoption of cleaner energy sources. Among other activities, the local experts supported the municipality in identifying the most appropriate tools and methodologies to be tested, adapted, and implemented in several pilot buildings. This section focuses on the assessment of tools most suited to integrate the methodological workflow already defined by the Technical Department "Environmental monitoring and SEAP implementation" for the upgrade of the current Naples SEAP into SECAP. PLINIVS-LUPT, based on the agreement with ANEA for the formation and support of public entities in the update of energy plans, committed to support the Municipality of Naples in the elaboration of the improved energy plan, based on selected available tools and resources presented in the SEACAP 4 SDG TOOLKIT, implementing the following steps:

(a) Assessment of the existing conditions and the possible situation after the implementation of the Toolbox tool/methodology, including energy consumption and characteristics of the analysed typologies, prioritisation of actions in the buildings and other relevant aspects to be highlighted as "low-cost actions", with the participation of stakeholders;
(b) Planned energy improvements. Overview of proposed actions and required investments. The section should include the objectives of the planned actions; the general administrative framework, including the actors involved and their responsibilities; planned technical interventions; barriers and obstacles and ways to close these gaps; and expected impacts, such as energy savings, renewable energy production, avoided CO_2 emissions, and social and climate impacts. Finally, the section should include the project's potential for replicability and alignment with the existing SEAP or an energy plan with similar ambitions.
(c) Behavioural change. Stakeholder engagement. An overview of the proposed stakeholder activities based on the previous analysis and the potential impacts expected, including the objectives, the general framework, the barriers, and obstacles identified and how these can be addressed.

PLINIVS-LUPT, together with ANEA, participated with selected team members in specific online training sessions on the TOOLKIT during the period from October to December 2022. The training sessions were preliminary to support the selected municipality, the City of Naples, with the specific objective of improving its energy plan.

At the end of the training sessions, having gathered all the information necessary for a critical evaluation of the tools, they were analysed together with a representative of the City of Naples in order to define the most suitable TOOLKIT tools to be used for the identified purpose. Continued dialogue with the administration allowed for a critical assessment based on real needs and, therefore, with a greater chance of success.

Table 1 provides a summary of the activities of the analyses carried out related to the project toolkits, highlighting relevant outputs and limitations noted in relation to the specific needs of the Naples municipality.

Table 1. Evaluation of SEACAP 4 SDG Toolkit.

Toolkit	Relevant Output	Limits for Implementation
IMPULSE	Structured database of characteristics of public building stock to monitor emissions and potential reduction; GIS based KPIs-processor, financial scheme evaluation tool	Needs a systematic methodology for collection of data on each public building.
EDUFOOTPRINT	LCA of carbon footprint and environmental footprint; high involvement of users and engagement of local communities, influence on behaviour at local scale	Needs a systematic methodology for collection of data on each public building. Handles individual buildings only.

Table 1. *Cont.*

Toolkit	Relevant Output	Limits for Implementation
EDUFOOTPRINTPLUS	Calculate the consumption of resources and activities carried out in the educational organisation and the environmental footprint of the schools for the owners and managers, considering the whole life cycle of the public building	Handles individual buildings only. Does not provide gradual renovation plans.
PRIORITEE and PRIORITEE PLUS	Strategy and toolbox to manage and monitor energy consumption, to assess the cost-effectiveness of EE and RES measures and to prioritize investments. Methodology about engaging people and transferring activities. Capacity building program that involves local authorities, regional partners and key local actors.	Access to experimentation is limited and requires registration, which is only available for specific countries
MED-ECOSURE	Build effective governance structures, influence behavioural aspects through user engagement	Educational buildings only; methodology could be extended to other typologies
CESBA MED S	Indicators and assessment process for retrofit strategy and scenarios; quantitative and qualitative aspects taken into account to assess both mitigation and adaptation criteria	Requires structured stakeholder involvement
STEPPING and STEPPING PLUS	To identify diverse investment scenarios that effectively align the interests of both the public and private sectors when it comes to making Energy Performance Contract (EPC) investments. This assessment is specifically tailored to evaluate an investment plan that involves a grouping or bundling of multiple buildings.	The process assumes the existence of state key performance indicators (KPIs) that are already available in the base-case scenario, as well as for different retrofit scenarios that are being considered.
BEEP-BIM	To facilitate energy and environmental enhancements, support is provided throughout the entire process, ranging from analysis and design stages to the actual implementation of an Energy Performance Contract.	Tool to use mostly during the conception phase.

Based on these reflections and taking into consideration both the identified limitations and the specific needs of the City of Naples that emerged following a number of meetings and working tables held in January 2023, the key tools proposed by SEACAP 4 SDG identified as particularly relevant to expand the potential of the tools already available to the City of Naples are:

- Public Building Energy Renovation—KPIs-processor's GIS plug-in and financial scheme evaluation tool, spreadsheet tool (Excel); GIS-based management support system (IMPULSE), for the direct integration in a GIS environment and the structured methodology to improve data collection for energy and environmental monitoring of public buildings, renovation planning and potential financing
- SBT-Sustainable Building Tool and SNT-Sustainable Neighbourhood Tool, online tool; framework assessment based on the SBE Method of iiSBE International (CESBA MED S), for the quality of identified indicators, linked to both climate mitigation and adaptation, and the direct link to the assessment process for retrofit strategies and scenarios, based on both quantitative and qualitative aspects
- School LCA Calculator. Online tool and spreadsheet (Excel) (EDUFOOTPRINT), given the relevant share of educational buildings among the different categories of public properties and the potential of improving the calculation of direct and indirect energy consumption in terms of carbon/environmental footprint
- MCBLL—Mediterranean Cross-Border Living Lab, Project management methodology and communication between the Living Lab, (MED-ECOSURE), given the relevant share of educational buildings among the different categories of publicly owned properties, and the possibility of achieving through the living labs a behavioural change about energy use which can in turn reduce energy consumption also for the residential sector (students as "environmental mentors" for their families)

The goal achieved was to provide a harmonized workflow (Figure 7) for the preparation of the Naples SECAP, linking the legacy tools available to the City of Naples with the tools identified for the SEACAP 4 SDG.

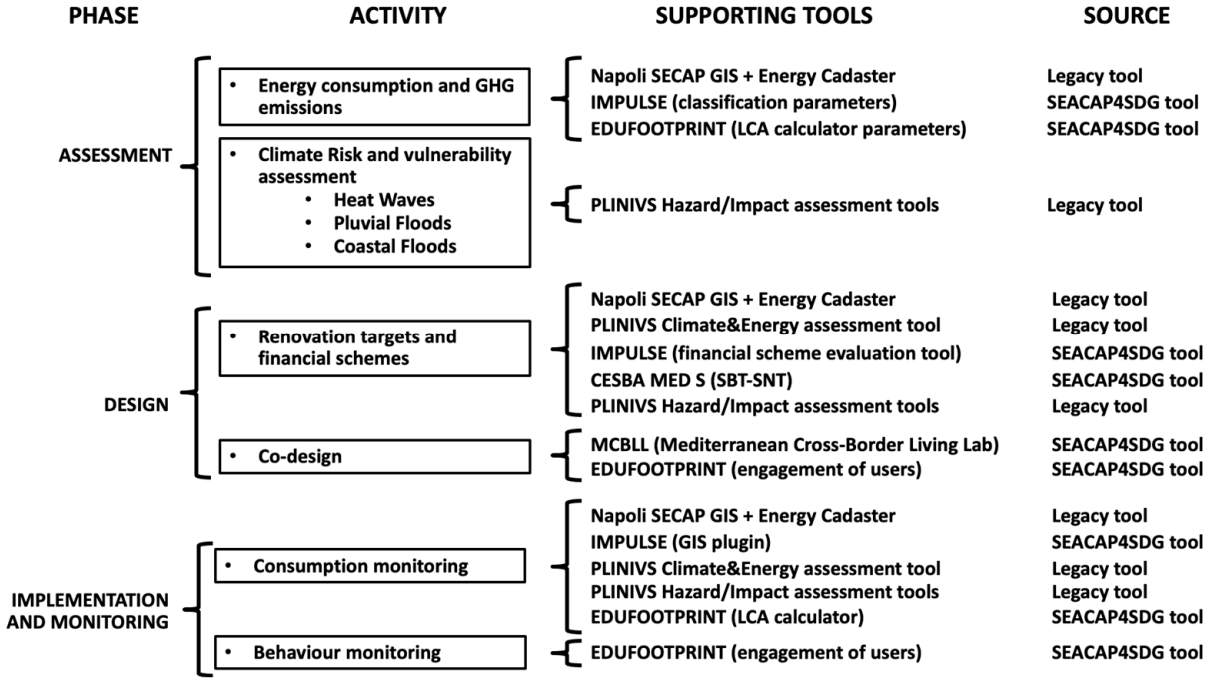


Figure 7. The envisaged workflow, in connection with the key activities linked to the Naples SECAP preparation and the supporting tools.

To ensure the possibility of developing a harmonized ecosystem of tools supporting the Naples SECAP implementation, a pre-training activity was carried out in January–February 2023, aimed at the following:

- Update of public building energy cadaster (including energy class assessment)
- Integration of updated energy cadaster in the Naples SECAP GIS database
- Identification of sample buildings for SEACAP 4 SDG tools testing (three school buildings, two office buildings)
- Detailed energy modelling of the sample buildings and upgrade of relevant data required by the SEACAP 4 SDG tools in the Naples SECAP GIS database.

3.2. Results of the Neapolitan SEACAP 4 SDG Living Lab with the Stakeholders

As a partner belonging to the northern shore of the Mediterranean, ANEA with the collaboration of PLINIVS-LUPT, was involved in the first level demonstrator applications of the project toolkits; this means that the main focus was on updating and developing the strategic plan of the selected municipality, in this case that of Naples, with the identification of possible study buildings but without moving on to practical implementation on the buildings themselves, which is the subject instead of the second level demonstrator reserved for the partner countries belonging to the southern shore of the Mediterranean.

Regarding the first level demonstrators, the training was carried out between February and April 2023 by implementing three workshops focused on the following methodological steps/tools:

- 27 February 2023—Integrating SECAP Napoli legacy tools with SEACAP 4 SDG tools (tool interface parameters and process workflow from preliminary assessment to planning, design and implementation)
- 31 March 2023—Assessment tools: Public Building Energy Renovation—KPIs-processor's GIS plug-in and financial scheme evaluation tool (IMPULSE), and School LCA Calculator (EDUFOOTPRINT)

- 26 April 2023—Co-design tools: MCBLL—Mediterranean Cross-Border Living Lab (MED-ECOSURE), and SBT-Sustainable Building Tool and SNT-Sustainable Neighbourhood Tool (CESBA MED S)

The training activities have been held with the participation of the Naples city administration manager, the energy managers of two Campania region universities (Federico II and Vanvitelli), staff from the Municipality of Naples and the Technical group.

In order to train those responsible for the municipal heritage of Naples, the Deputy Mayor, who also has the function of Environmental Adviser, as well as various persons responsible for the technical services of the municipality such as the Energy Manager, managers of public buildings (e.g., education, sports buildings), and the head of environmental control services, were contacted and invited to various training workshops by email and through various meetings organised upstream. The methodological background for stakeholder involvement and LL creation has been defined within projects and activities carried out by the City of Naples with the support of University of Naples Federico II, mostly within H2020 CLARITY and participation in the Horizon Europe KNOWING project.

The stakeholder involvement phase was preceded by an overview on the identified climate change impacts, namely:

- Heatwaves, health and energy;
- Flooding and infrastructure (including both pluvial flooding and coastal flooding).

The critical aspects in the workshop's organisation were:

- Adapt the workshops to the regional challenge, focussing of the needs of partners and stakeholders;
- provide a space for dialogue and interaction with other local stakeholders representing public authorities, the scientific community, and technical services.

To identify the stakeholders to involve, we had to monitor climate change impacts on sectors and services in the Neapolitan territory. Then, we were able to identify public stakeholders, private subjects and members of civil society that would be necessary and/or interested in the Local Lab, knowledge-sharing as well as at the co-design of a "2050 vision" for the city and of an implementation pathway based on short-, medium- and long-term priorities, to which performance indicators with respect to the set objectives should be linked. The methods of onboarding and engagement of initial stakeholders, any additional stakeholders and citizens (e.g., workshops, regional scale events, press releases, social media content) were carried out in a coordinated and strategic manner to ensure that the interactions between the actors lead to the achievement of the LL objectives.

The stakeholders identified were either present in the area affected by the risks previously defined, or managers or owners of the infrastructure or services impacted by risks. The target audiences were policy makers and administrations (regional planning, environment, water, health), economy and industries (energy, construction, infrastructure) and civil society NGOs. The Stakeholder and Citizen Engagement Plan took into account stakeholders included in a continuously updated database and organised into specific categories. Further stakeholders are being engaged for the continuation of the Naples LL in connection with the activities of the KNOWING project, adding to the initial list nine public stakeholders from regional and city authorities, four private companies, and one NGO. Some were preliminarily met at events, such as EnergyMed 2023.

The stakeholder involvement plan, containing the following information:

- WHAT: The Local Lab aim and the main workshop
- WHERE: The Metropolitan City of Naples (multi-risks and impacts)
- HOW: Relevant stakeholders' involvement (role and sector of interest, importance for the project, interest in taking part).

Significant feedback was received as a result of the application of that methodology. The most interested results came from the involved stakeholders so far, especially on the usefulness of assessment tools able to deliver quantitative indicators that can support the accounting of

public investments in the short-term, in connection with the next-generation EU funding and the need for accounting project investments through the EU Taxonomy principles.

The importance of activating a dialogue between public and private actors to identify potential collaboration opportunities, but also diverging interests and existing conflicts, was also identified as a priority, especially in the context of investment in schools and sports facilities. The main interest concerned the possibility of transferring user-oriented solutions and strengthening the cooperation and trust between the public and private sector.

The complexity of some of the proposed tools did not allow acquiring a full understanding of the capabilities linked to their regular use in building and open space design and retrofitting, although a general interest in learning more about their practical usability in the daily tasks of different stakeholders was recognised. The innovation potential of the LL approach attracted the interest of both public and private stakeholders, especially in relation to their capacity for meeting the novel requirements stemming from the more recent EU addresses and regulations (e.g., EU Taxonomy and the new EPBD). LL sustainability, as a regular practice for all public investments and projects at the city, neighbourhood and building/open space scales, remains a challenge, in the Naples context, for the abovementioned structural lack of human and financial resources, given the scale and complexity of the challenge at hand.

The mobilization of public institutions, the private sector and NGOs in supporting the climate and energy transition of the city is a key to the continuity of funding needed to continue carrying out such action in the next decades.

During the Naples LL setup, the clear indication that emerged concerned the need to better communicate the specific social, economic and environmental co-benefits of energy and climate action, tailored according to stakeholder priorities in their respective fields.

As an example, aspects considered as key components for the dissemination and communication strategies in relation to school building energy and climate retrofitting included the importance of environmental education of a new generation to trigger behavioural changes and the potential role of students as "environmental mentors" for their families to decrease energy consumption, and, in the case of sports facilities, the return in terms of the "corporate sustainability" image of involved sports associations as a trigger for private investments.

Future directions in development could focus on increasing stakeholder involvement, through the production of ad hoc dissemination and communication materials, with the aim of providing a simplified conceptualisation of the Naples LL methods and expected results to reach a wider audience and, ultimately, the general public; an illustrative brochure on the implementation of the Naples SECAP could also be developed, including examples of good practices and success stories from EU cities and guidelines for priority actions in the local context. This type of material could also be disseminated in school contexts to promote sustainable development awareness among the population. Finally, it is believed that with the necessary in-depth study and analysis of individual critical issues, the methodology could be applied to additional municipalities in the country.

4. Conclusions

The Naples LL intends to integrate climate mitigation and adaptation strategies within a strategic local plan as the SECAP, in a context that, as many Mediterranean cities present several complexities in terms of technical and financial resources available to local authorities, limits private investments and the ability to use EU structural funding (e.g., cohesion funds), with limited awareness of local communities with respect to energy and environmental issues.

Directing local action to contribute effectively to EU objectives requires a major effort in terms of coherence between planning, design, implementation, and monitoring of interventions. It also requires a synergic action by public administrations, scientific institutions, private actors, and civil society in building a shared and ambitious long-term vision, supported by a realistic and effective implementation roadmap, able to guarantee

the correct use of the available technical-scientific and financial resources, to generate an important leverage effect in terms of private investments, starting from an adequate use of EU, national and regional contributions.

Involving the participation of various local stakeholders within the Living Lab, including government bodies, community organizations, and residents, permitted identifying mutually beneficial opportunities across policies and programmes while developing capacities of governments for cross-sectoral planning and ensuring vertical alignment and horizontal synergies to avoid siloed responses, establish a solid governance system, achieve durable coordination and foster a collaborative understanding of the key challenges within the urban system, considering environmental, functional-spatial, and socio-economic aspects from a multi-stakeholder perspective.

The outcome resulted in the implementation of the improved energy plan based on the selected tools offered by the SEACAP 4 SDG Toolkit and the combination of legacy tools available to the Municipality of Naples thanks to its long collaboration with partners such as ANEA and UNINA to bridge two crucial knowledge components that should support the path to a climate-resilient vision for 2050: (1) evidence-based and data-driven simulation tools and (2) knowledge-sharing and co-design tools. The opportunity offered by the KNOWING project to continue the Naples LL experience until 2025 can offer a solid platform for follow-up on strategic exchanges in a multi-stakeholder context, considered essential for the success of the Naples SECAP.

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