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CITY MINDED
City Monitoring and
Integrated Design for Decarbonisation

CITY MINDED – City Monitoring and Integrated Design for Decarbonisation

1ST CITY DECARBONISATION ITINERANT WORKSHOP - REPORT

23 – 27 NOVEMBER 2020, SIENA

Responsible Partner:

UNIVERSITÀ DI SIENA 1240

ecodynamicsgroup

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1. Introduction

The 1st City Decarbonisation Itinerant Workshop consisted in a virtual workshop carried out on the Cisco Webex platform and organized in combination with 2nd Project Management Meeting.

The objective of the workshop was to put together project partners (teachers, researchers, or trainers), students, and local stakeholders in order to address common onsite challenges and define collaborative urban decarbonisation roadmaps for the Ravacciano neighbourhood in Siena through a 'learning-by-doing' method.

The workshop has been divided into training and co-working sessions; each day 2-3 persons (teachers, researchers, or trainers) from each partner organization presented a training session to implement a site-specific urban decarbonisation roadmap for the selected neighbourhood. After the training seminars each partner organized a co-working session with practice exercises to be done by the students.

The Involved students (around 20) attend the Master's Course in Ecotoxicology and Environmental Sustainability of the Department of Physical Sciences, Earth and Environment at the University of Siena.

UNISI also involved some stakeholders from the Municipality of Siena to present the URBiNAT project and some virtuous experiences that are taking place in the municipality.

2. Agenda

Day 1 – 23rd November 2020

Time	***Name of the presentation***	***Responsible partner***
14:00	Registration of the participants	
14:05	Welcome speech	IRENA
14:10	Introduction and opening of the 1st City Decarbonisation Workshop	UNISI
14:30	Presentations of the Stakeholders – Municipality of Siena	UNISI
15:30	Presentation of the City of Siena and the target district/neighbourhood	UNISI
16:00	Break	
16:15	Co-working session	UNISI
17:45	Conclusion	
18:00	End of day 1	

Day 2 – 24th November 2020

Time	***Name of the presentation***	***Responsible partner***
14:00	Registration of the participants	
14:05	Assessment and analysis of vulnerability associated with climate change. - Theoretical introduction: Vulnerability to Natural Hazards in a Climate Change Context - Methodological introduction: Vulnerability Index calculation and representation	UPO
14:50	Break	

15:00	Co-working session (work in groups)	UPO
16:50	Break	
17:00	Short presentation of group work results	
17:30	Global results of the workshop	
17:45	Discussion about and conclusion of the workshop	
18:00	End of day 2	

Day 3 – 25th November 2020

14:00	Registration of the participants	
14:05	Place-making framework – training seminar Introduction to town planning Ecological networks & Green infrastructure approach Urban and Landscape design	UNIROMA3
15:50	Break	
16:00	Co-working session (work in groups) Map interpretation SWOT analysis and characterisation Interactive brainstorming	UNIROMA3
17:30	Final presentations	
18:00	End of day 3	

Day 4 – 26th November 2020

14:00	Registration of the participants	
14:05	Energy Efficiency and Renewable energy technologies in the active service of the City decarbonisation processes – training seminar	IRENA & MIEMA

	IRENA – Istrian Regional Energy Agency (Croatia) MIEMA – Malta Intelligent Energy Management Agency	
15:30	Break	
15:45	Co-working session (group work) Identification of building types in the target neighborhood in Siena Proposals for improving the energy efficiency of buildings in the area Proposal for the integration of Renewable energy sources in the buildings Identification of any barriers for energy renovation in the area Estimation of energy savings/energy production in the neighborhood	IRENA & MIEMA
17:30	Final presentations	
18:00	End of day 4	

Day 5 – 27th November 2020

14:00	Registration of the participants	
14:05	Welcome speech, IRENA	IRENA
14:05	Wrap up of the performed activities, UNISI	UNISI
14:30	Presentation of the Co-Working session results	UNISI
15:00	Break	
15:10	Final discussion	
16:45	Conclusion and end of the City Decarbonisation workshop	
17:00	Presentation of the project during the “BRIGHT” event	UNISI

3. Participants

Name and Surname	***Organization***	***Day 1***	***Day 2***	***Day 3***	***Day 4***	***Day 5***
Partners						
Andrea Poldrugovac	IRENA	X	X	X	X	X
Antonio Franković	IRENA	X	X	X	X	X
Riccardo Maria Pulselli	UNISI	X	X	X	X	X
Matteo Maccanti	UNISI	X	X	X	X	X
Valentina Niccolucci	UNISI	X	X	X	/	X
Massimo Gigliotti	UNISI	X	X	X	X	X
Simone Bastianoni	UNISI	X	X	X	/	X
Michela Marchi	UNISI	X	X	X	X	X
Anna Laura Palazzo	UNIROMA3	/	/	/	X	/
Federica Di Pietrantonio	UNIROMA3	X	X	X	X	/
Romina D'Ascanio	UNIROMA3	X	X	X	/	X
Lorenzo Barbieri	UNIROMA3	X	X	X	X	X
Francesca Paola Mondelli	UNIROMA3	/	X	X	/	/
Josefina López Galdeano	UPO	X	X	X	/	X
Pilar Paneque	UPO	/	X	/	/	/
Jesus Vargas	UPO	X	X	X	/	X
Diane Cassar	MIEMA	X	X	X	X	X
Stakeholders						
Iuri Bruni	Municipality of Siena	X	/	/	/	/
Mariapiera Forgione	Municipality of Siena	X	/	/	/	/
Pietro Romano	Municipality of Siena	X	/	/	/	/
Students						
Anna Giada Sanna	UNISI_student	X	X	X	X	X
Alessandra Piccinini	UNISI_student	X	X	X	/	X
Andrea Calantropio	UNISI_student	X	X	X	X	X
Anna Gigi	UNISI_student	X	X	X	X	X
Aurora Bovone	UNISI_student	X	X	X	X	X
Benito Arena	UNISI_student	X	X	X	X	X
Chiara Dettoto	UNISI_student	X	X	X	X	X
Debora Vaselli	UNISI_student	/	X	/	/	/
Elisa Quarta	UNISI_student	X	X	X	X	X
Emanuele Cosimo	UNISI_student	X	/	/	X	X
Francesco Bonucci	UNISI_student	X	/	X	/	/
Gianni Battaglia	UNISI_student	X	X	X	X	/

Giulia Gai	UNISI_student	/	/	X	/	X
Maria Piegari	UNISI_student	X	X	X	X	X
Nicolò Pieri	UNISI_student	X	/	X	X	X
Roberta Russo	UNISI_student	X	X	X	X	X
Samuele Corti	UNISI_student	X	X	X	X	X
Sara Quartieri	UNISI_student	X	X	X	X	X
Valentina Marcandalli	UNISI_student	X	/	/	/	/

4. Report from the workshop

Case Study

The Ravacciano neighbourhood hosts 1631 inhabitants, with an average density of 35.6 people/hectare. The first settlement has been built during the ‘30s. Then the built area has grown until the ‘70s and ‘80s. The valleys of Follonica and Ravacciano, separated by the ancient wall, connect the old city to the Ravacciano neighbourhood and the productive and commercial district down the hill. These valleys are partially accessible to people and are fractioned into several private properties, besides a few areas with public ownership.
Data on age and gender of the population in Ravacciano neighbourhood show that females are almost 56% of residents. Moreover, almost 15% are under 18 years old (248), 38% are over 18 and under 50 (636), 26% are over 50 and under 70 (430) and the over 70 are almost 22% (362). The average age in district in 2019 is 48.1 years.

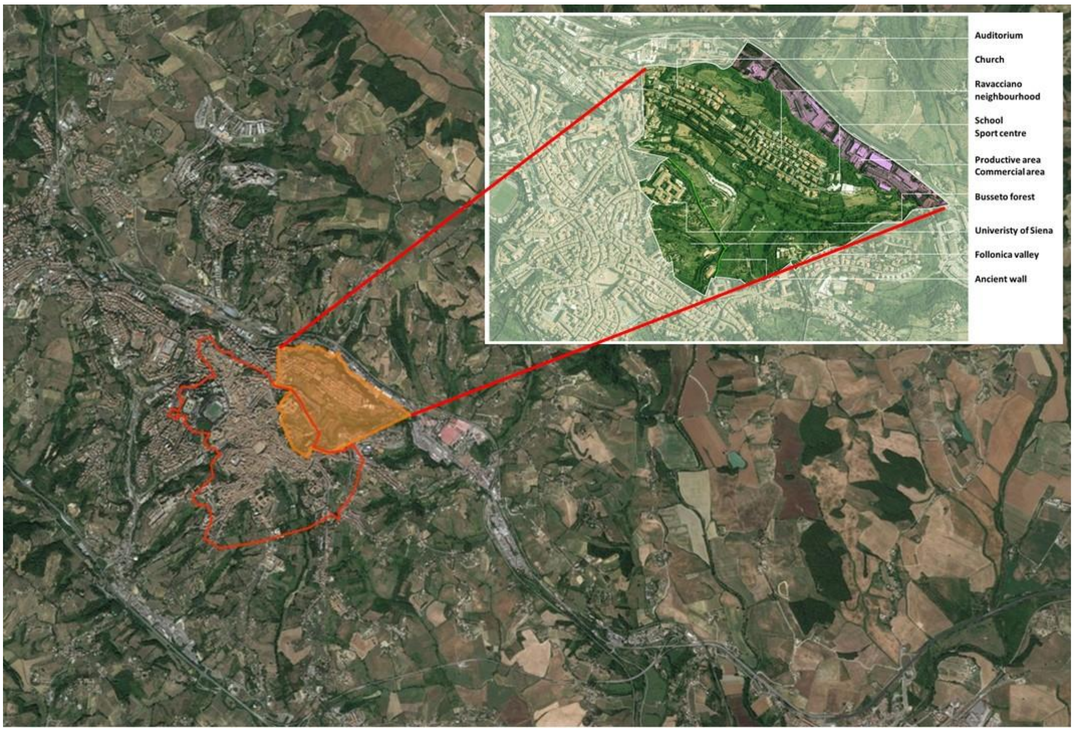

Figure 1. Case study area: Ravacciano neighbourhood and valleys.

Local Stakeholder Engagement

For this workshop, UNISI involved three representatives from the Municipality of Siena:

- Dr. Iuri Bruni talked about the Horizon2020 URBiNAT project (Urban Innovative & Inclusive Nature) that involve 28 partners, 7 cities (including Siena) and 15 countries.
  URBiNAT focuses on the regeneration and integration of deprived social housing districts. Interventions focus on the public space to co-create with citizens new urban, social, and nature-based relations within and between different neighbourhoods. Taking the full physical, mental, and social well-being of citizens as its main goal, URBiNAT aims to co-plan a Healthy Corridor as an innovative and flexible nature-based solution (NBS), which itself integrates a large number of micro NBS emerging from community-driven design processes. The case study area in Siena for the URBiNAT project, is the Ravacciano neighbourhood and and the adjoining valleys (more information about the project: https://urbinat.eu/) and this allows for joining efforts and creating synergies with this Horizon 2020 project, making the City Minded partners and students interact with stakeholders involved in the URBiNAT project.
- Dr. Mariapiera Forgione talked about the Horizon2020 URBiNAT project more in detail about communication aspects and how this is a success factor for participation processes. She reported three examples of “Urban event” in Siena that could be prototype as NBS: the “Fonte d’Ovile”, an historical water basin in the Ravacciano valley, “The Greenery Theatre” in the San Miniato neighbourhood and the “Siena wall” experience.
- Arch. Pietro Romano talked about the experience connected to the creation of urban vegetable gardens in the San Miniato neighbourhood in Siena and the project “100Orti in Toscana” of the Tuscan Region (more information here: https://www.regione.toscana.it/speciali/centomila-orti.

Training session

UNISI

The UNISI contributions was divided into 2 presentations:

- "Urban Carbon Accounting Siena" made by Dr. Matteo Maccanti, on 23rd November,
- "Mitigation measures for a Carbon Neutral vision of the Ravacciano neighborhood" made by Dr. Matteo Maccanti, on 27th November.

The Carbon Accounting Methodology and the case study were presented to the students.
This procedure, substantially inspired by the IPCC standard methodology for GHG emissions inventory of Nations, has a dual role: to both assess the Carbon Footprint of urban neighbourhoods and to estimate the effects, in terms of Carbon Footprint mitigation, of action plans addressed to carbon neutrality.
The carbon accounting methodology shown to the students is based on the one developed as part of the EU FP7 City-Zen Project (Pulselli et al., 2018, 2019a, 2019b, 2021) which aimed to establish a general approach for urban neighbourhood retrofitting in European cities for decarbonisation including the monitoring of carbon emissions and the estimate of the effects of mitigation measures.
As the first step, a brief explanation on what is the carbon footprint and how it is calculated was made.
To manage the workshop in remote mode, instead of in presence, and address the work with students, a preliminary presentation of the case study and the City Minded project has been made on November the 18th (4 hours) by Prof. Simone Bastianoni and Dr. Riccado M. Pulselli.
The first assessment focussed on the Municipality of Siena (an area of 118 km^2): a simplified carbon accounting framework has been conceived, for assessing the Carbon Footprint of the area and the Carbon Footprint mitigating effects of integrating decarbonisation scenarios, including residential energy demand, fuel use for mobility, waste and water management, food consumption and carbon uptake by urban ecosystems. The assessment also allowed for profiling the typical household in the Municipality as a functional unit for assessing the impact of the neighbourhood and the mitigation scenario. The ex-ante evaluation of the effects of mitigation strategies concerning different spatial scales, from neighbourhoods to households, until individual citizens, and temporal horizons (short-, medium-, long-term mitigation measures) was performed (these mitigation measures mainly refer to Pulselli et al., 2019).
The Carbon Footprint of the Ravacciano neighbourhood (0.46 km^2) was also presented and visualized in terms of virtual forestland equivalent, i.e. the equivalent surface of forest that would be needed to absorb carbon emissions generated within the area. In the end, a dynamic representation of the "decarbonisation" plan for city neighbourhoods by 'crunching' the virtual forestland was carried out.

UPO

Climate change forecasts predict an increase in the frequency and intensity of natural hazards in Italy, among the most serious droughts, floods, and heat waves (IPPC, 2014). The objective of this workshop is to make an approach to the hybrid nature of risks, in which the interaction between natural events and social processes are related to generate risk situations. A theoretical introduction was made on the need to turn risk management strategies towards prevention, mitigation, and adaptation strategies. Vulnerability assessment and analysis have become one of the main tools for preventing and mitigating natural hazards effects on society, economy, and environment (UNISDR, 2015; EEA, 2018). The UPO contribution aimed to introduce students in both theorical and operational assessment and analysis of vulnerability associated with climate change.
The workshop specially focused on

1) Setting up a method that allow students to understand the different components and dimensions of vulnerability. What and why is important to analyze;
2) Introducing students to different research techniques, tools, and data sources;
3) Training compound index calculation, representing, comparing, and analyzing results; and
4) Highlighting the importance not only to measure vulnerability but also to analyze it.

UNIROMA3

The team made three presentations on 25th November:
- “Introduction to Town Planning” by Dr. Barbieri.
- “Ecological Networks and Green Infrastructure approach” by Dr. D’Ascanio.
- “Introduction to landscape analysis of Siena” by PhD candidate Mondelli.

The first seminar introduced the place-making approach and the concept of decarbonisation. It started with a short video from the tv series “The Hitchhiker’s Guide to the Galaxy”, which shows how planning should not be: top-down, remote decisions not taking into account their effects on the population. The video was the occasion to talk of new approaches, which strive to improve the administration’s communication skills and the involvement of inhabitants.
Planning levels in Italy were explained, focusing on the target context (Tuscany, the province and town of Siena). While regional and provincial plans entail general provisions at a large scale, municipal plans have two dimensions, a long-term one (*piano strutturale*) entailing over-arching rules, and a short-term one (*regolamento urbanistico*) with more specific rules affecting land-use and private property and thus having a larger influence on people.
The second presentation aimed at explaining the concept of Ecological Networks (EN) within spatial planning and the new approach to Green Infrastructure (GI). If EN follow a biological and ecological approach, GI is an innovative way for spatial planning to take into account the benefits to communities produced by nature.
The concept of EN has evolved into a part of the current model of GI according to which the same area can offer multiple benefits if its ecosystems are healthy.

The GI approach analyses the natural environment so to highlight its function, and seeks to put in place mechanisms that safeguard critical natural areas and provide multiple functions and benefits to the communities, matching ecological, social, cultural and economic issues at different scale.
Examples of planning of ecological networks were brought within the planning system of Tuscany, and the GI approach was explained focusing on multifunctionality and transcalarity. Furthermore, the concept of 'trame verte et bleue' was explained as a good practice, and some examples of nature based solutions were given.
The final seminar aimed to describe some theoretical concepts and conduct a brief analysis of the landscape of Siena. Firstly, historical cartographies were shown to highlight the relationship of the city with the morphology of the territory, along with some visual perceptions of Siena's landscape over the centuries.
In the second part, Siena was described as a prototype of environmental sustainability in relation with the resource water and the system of aqueducts that characterizes the city ("bottini").
The third part highlighted the efficiency of landscape analysis for the quality of planning at territorial and urban level.
Finally, the landscape analysis and interpretation were applied to Ravacciano, showing how to conduct a landscape analysis using aerial photographs, highlighting perceptions, visual connections and forms of the territory.

IRENA and MIEMA

The energy agencies IRENA and MIEMA presented the following topics on the 26th November:

- "Energy Efficiency in the active service of the City decarbonisation processes" by Andrea Poldrugovac, IRENA.

- "Renewable Energy technologies in the active service of the City Decarbonisation processes", by Diane Cassar, MIEMA.

The first presentation focused on the topic of energy efficiency, with particular focus on the existing building stock of the Ravacciano neighbourhood and its energy-efficient improvement by sharing the knowledge about energy efficiency, by detecting potential problems and identifying solutions during the Co-working session and by defining energy efficiency measures which will act as an integral part of the urban decarbonisation roadmap for the target neighbourhood. The presentation was divided into six chapters: presentation of the working group, energy efficiency in the active service of the city decarbonisation process, energy efficiency measures, nearly zero-energy buildings, energy refurbishment of heritage buildings and how to finance renovations. The focus of the seminar was on how to achieve energy-efficient buildings in the target neighbourhood. Among different energy consumers in the urban areas, buildings were chosen since the building stock is responsible for approximately 40% of EU energy consumption and 36% of the greenhouse gas emissions. Buildings are the single largest energy consumer in Europe and about 35% of the EU's buildings are over 50 years old and almost 75% of the building stock is energy inefficient. Unfortunately, only about 1% of the building stock is renovated each year and this numbers in the following years will have to change rapidly if the targets set in the EU Green Deal will be achieved. One of the latest and most important initiatives, the “Renovation Wave” was presented to the students, which represents a flagship initiative of the EU Green Deal and of the Next Generation EU recovery plan. The ambition of the Renovation Wave is to rapidly double the current renovation rate of buildings to boost climate protection and circularity while creating thousands of new jobs. To achieve planned targets, it is necessary to conduct relevant energy efficiency measures, which were presented to the students in five typical categories aimed to reduce heating demand, cooling demand, energy requirements for ventilation, energy use for lighting and energy used for heating water. The theoretical session was concluded with presenting what are “Nearly zero-energy buildings (NZEB)”, how to conduct energy refurbishment of heritage buildings and at the end how to finance the renovations.

The second presentation focused on the integration of renewable energy systems within the urban environment. The following six main topics were presented: urban energy systems and the urban energy strategy, renewable energy technologies, prosumers and self-consumption, urban micro-grids and energy communities, building typologies and challenges to energy renovation and finally a presentation of different best practices. Photovoltaic technologies (conventional panels and BIPV), micro-wind and combined heat and power systems were presented as possible solutions to be integrated in different buildings types within the neighbourhood. The potential of energy storage solutions and smart micro-grids were also discussed to further maximise self-consumption of energy produced through renewable energy technologies within the buildings.

Co-working session

UNISI

Description of the exercise

The exercise proposed by the University of Siena, during the City-Minded Workshop, had the following aims:

1) Quantifying the Carbon Footprint (CF) of the Municipality of Siena and the Ravacciano district;
2) Quantifying the virtual equivalent forest area, needed to absorb GHG emissions;
3) Discussing potential policies and simulating the CF mitigation of Ravacciano district.

Students were divided into 5 Working Classrooms and, within each group; they nominated a leader who would play the role of spokesperson. Students had to perform one exercise at a time lasting 10 minutes, discussing among themselves. At the beginning of the tutorial, students were provided with an EXCEL file, containing the information needed for the calculations. At the end of each exercise, students would meet in the Common Classroom to talk about the results.

The CF of the Municipality of Siena and the Ravacciano district were inventoried, considering the emission sectors of origin, divided into impact sub-categories (Figure 2).

Emission sectors	Impact sub-categories
1) Energy	✓Transport ✓Heating ✓Energy in industry ✓Electricity ✓Waste incineration ✓Anaerobic digestion
2) Industrial Processes	✓Material production
3) Waste	✓Landill ✓Composting plants ✓Wastewater treatment plants
4) Agriculture, Forestry and Other Land Uses (AFOLU)	✓Land use change ✓Agriculture ✓Livestock ✓Green areas uptake

Figure 2. Emission sectors and impact sub-categories.

Emissions were calculated, applying the following basic Equation 1:

$$E/year = A \times EF \quad \text{(Eq. 1)}$$

where,

E/year = GHG emissions in one year (kg of pollutant);

A = activity data (consumption of an energy source; e.g. use of natural gas for heating);

EF = emission factor per unit of activity and per specific pollutant.

The assessment methodology associates a specific emission factor (*EF*) to each human activity (*A*). The virtual equivalent forest areas, needed to absorb the GHG emissions, were estimated considering a removal rate of 1.3 kg CO_2 $(m^2)^{-1}$.

The EXCEL file also provided a list of mitigation policies, indicating the consumption savings, the policy penetration in the population and the potential electricity production from renewable resources.

Students discussed the benefits of the environmental policies and simulated the Carbon Footprint mitigation due to the implementation of some policies.

Results

The CF of the Municipality of Siena is reported in Table 1, indicating that mobility had the greater impact, followed by the electricity consumption and the fossil fuels use for energy production.

Table 1. CF of the Municipality of Siena.

ACTIVITY SECTORS	t CO_2eq	%
ELETTRICITY	**103,113**	**31**
Residential	40,689	12
Service sector	34,436	10
Public	8877	3
Industry	12,518	4
Agricultural	6594	2
ENERGY (Natural gas and fuels)	**101,685**	**31**
Residential	89,938	27
Industry	8851	3
Agricultural	2896	1
MOBILITY	**104,090**	**32**
SOLID WASTE	**19,793**	**6**
WASTEWATER	**1201**	**0,4**
TOTAL	**329,881**	**100**
FOOD proteic diet	103,775	24
FOOD balanced diet	67,313	17
FOOD balanced diet + local food	39,266	11
UPTAKE	**-21,935**	**-7**

The virtual equivalent forest area of the Municipality of Siena is 244 km^2, compared to 16 km^2 of the current forestland (Figure 3).

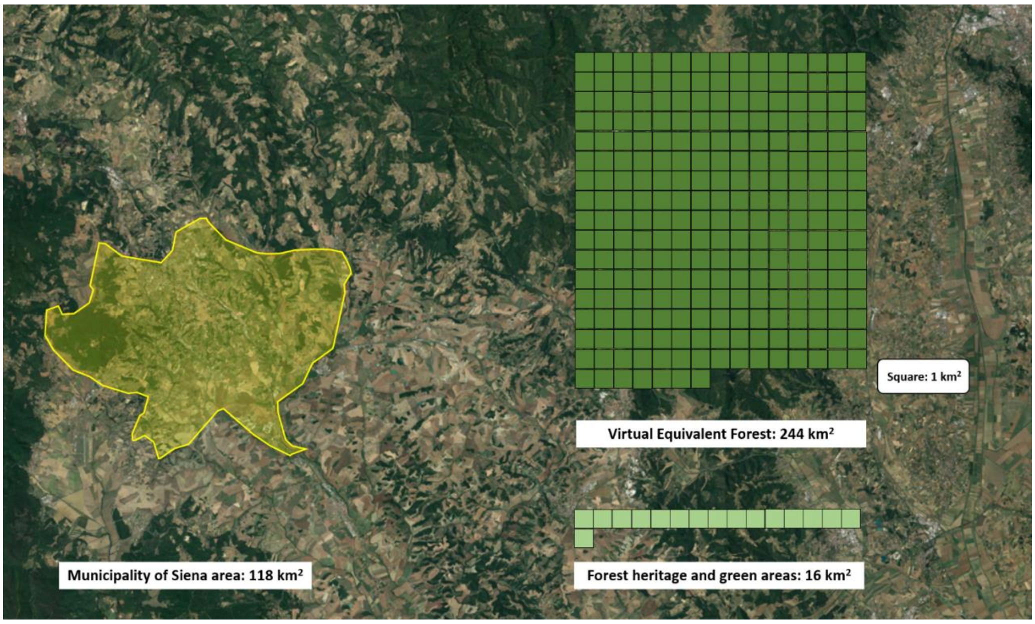

Figure 3. Virtual equivalent forest area of the Municipality of Siena.

Table 2 shows the CF of the Ravacciano district and its virtual equivalent forest area; the values of Ravacciano cover only 3% of those referred to the Municipality of Siena.

Table 2: CF and virtual equivalent forest area of the Ravacciano district.

ACITIY SECTOR	**CF**	**Virtual equivalent forest**
	t CO_2eq	**ha**
ELECTRICITY	**2,471**	**183**
Residential	1,197	89
Service sector	1,013	75
Public	261	19
Industry	0	0
ENERGY (Natural gas and fuels)	**2,720**	**201**
Residential	2,720	201
Industrial	0	0
MOBILITY	**3,148**	**233**
SOLID WASTE	**599**	**44**
WASTEWATER	**36**	**3**
FOOD proteic diet	3,138	232
TOTAL	**12,111**	**897**

The CF mitigation of Ravacciano district, due to the environmental policy implementation, is shown in Figure 4. The most beneficial policies are the electricity production from photovoltaic (PV) panels and the transition to a decarbonized electric system, to achieve the carbon neutrality condition.

Figure 4: CF mitigation of Ravacciano district.

Note: 01) Reduction of energy consumption; 02) bicycles; 03) Less waste production; 04) Balanced diet; 05) Nature-based solutions, 06) Thermal insulation; 07) Smart working; 08) Increase in waste recycling; 09) Local food; 10) PV panels; 11) Public transport and bike sharing; 12) PV canopy; 13) Heat pumps; 14) Electric mobility; 15) Other PV panels; 16) Uptake.

UPO

Description of the exercise

The exercise proposed completed the theoretical introduction. This exercise was divided into three complementary parts: vulnerability assessment, vulnerability analysis and results' debate. The starting point was the risk equation (risk = hazard * vulnerability). To assess vulnerability, we adopted the methodological framework proposed by Intergovernmental Panel on Climate Change (IPCC) (2012, 2014) which defines vulnerability based on three main components: Exposure, Sensitivity, and Adaptive capacity. Figure 5 shows the methodological proposal to assess vulnerability.

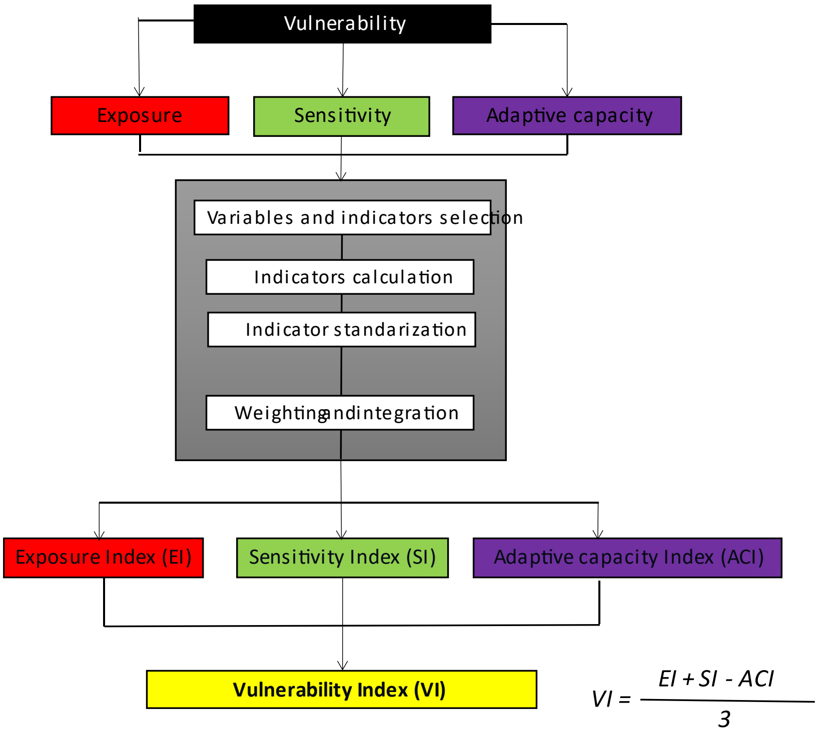

Figure 5. Methodological framework.

To calculate each components a set of variables and indicators were selected. This variables and indicators were selected based on two criteria:

1) availability of data;

2) enough diversity to capture the multidimensional nature of vulnerability (social, natural, economic, institutional, and technological) and allowing students to use different tools and research techniques and data.

Tables 3, 4 and 5 introduce the set of indicators selected for each component.

Table 3. Exposure variables, indicators and units of measure.

	Variable	Indicator	Unit of measure
Exposure	**Population**	**Population exposed** (Total county population/total region population)	**%**
	Housing stook	**Housing stock exposed** (Total county houses/total region houses)	**%**
	Green areas	**Green areas exposed** (Total green areas/total area)	**%**

Table 4. Sensitivity variables, indicators, and units of measure.

	Variable	Indicator	Unit of measure
Sensitivity	**Population**	**Individual relative poverty incidence** (Individual regional relative poverty incidence/individual national relative incidence)	**%**
	Population	**Dependent population** (population under 16 and over 65/ total population)	**%**
	Housing stook	**Substandard housing** (County rotten windows, floors buildings/National rotten windows, floors buildings)	**%**
	Housing stook	**State of the Building** (number of poor or very poor buildings)/(number of total residential buildings)	**%**
	Green areas	**Green urban areas** (Green urban areas/inhabitants)	**%**

Table 5. Adaptive capacity variables, indicators, and units of measure.

	Variable	Indicator	Unit of measure
Adaptive capacity	**Climate change planning**	**County adaptation plan** Document review	**0-1**
	Emergency planning	**County emergency plan** Document review	**0-1**
	Education	**Educational level** Primary education, lower secondary education or upper secondary education	**%**
	Climate change and natural risk perception	**Climate change and Risk Perception** Survey	**0-1**
	Institutional Trust	**Institutional Trust** Survey	0-1

Once the indicators of each component were calculated the triangle structure of vulnerability (adapted from Liu et al. 2013) was used to analyse the contribution of each component to the final vulnerability value. Finally, the results were presented by a representative of each students' working group.

Results

Figure 6 shows the vulnerability assessment results for each study case (exposure index, sensitivity index, adaptive capacity index and the final vulnerability compound index).

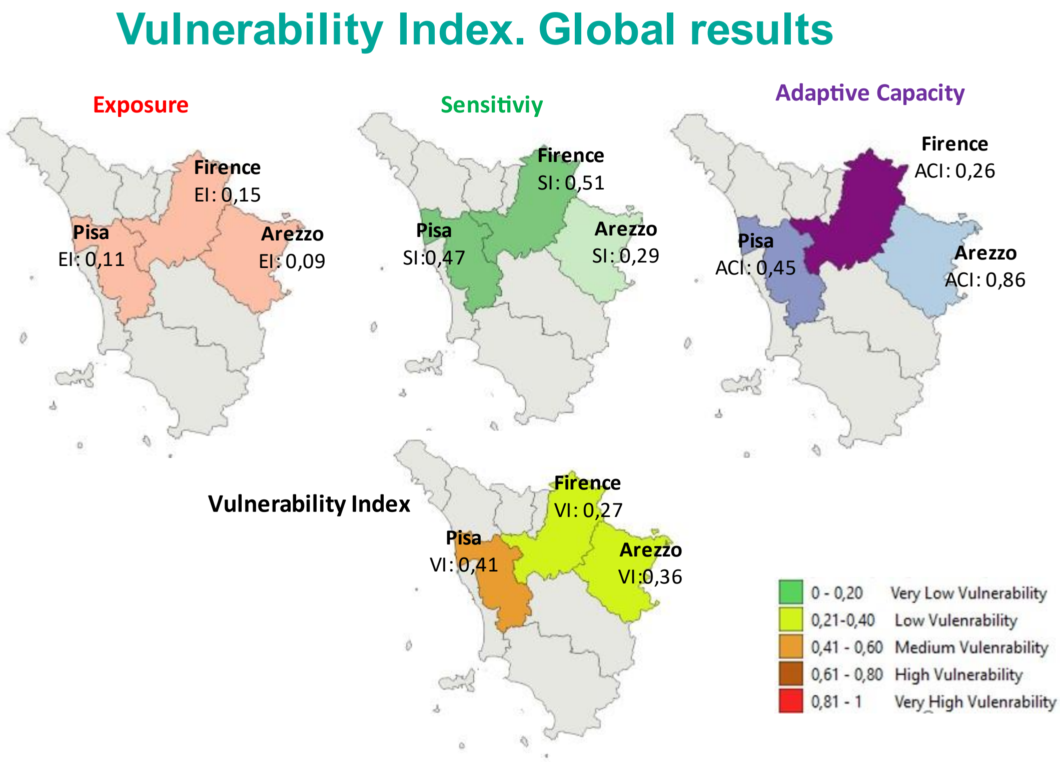

Figure 6. Vulnerability Index results.

As shown in Figure 6, exposure presents low results in three study cases, however sensitivity index presents higher results in all cases. Adaptive capacity presents high differences between the three study cases. This component introduces those important social and institutional variables which are more difficult to measure (risk perception, institutional trust, climate change adaptation).

Figure 7 shows the vulnerability structure triangle results. Arezzo's study case presents a low adaptive capacity and so, the contribution of this component to the final value of vulnerability is the highest (adaptive capacity is inversely related to vulnerability). Pisa and Firenze results show that sensitivity is the component which contributes the most to the final value of vulnerability.

Vulnerability Structure Triangle. Global results

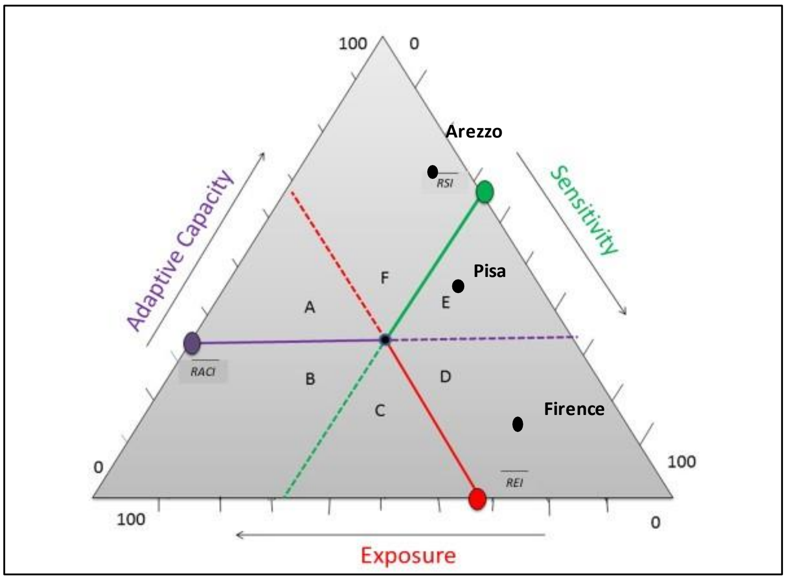

Figure 7. Vulnerability structure triangle results.

UNIROMA3

The co-working session introduced the concepts of decarbonisation and urban environment and used the tool of community mapping in order to set a place making framework to plan and design green infrastructure for decarbonisation at local scale. The team adopted a wide perspective on decarbonisation, by including those aspects that highlight a connection to other topics:

- decarbonisation connected to town planning, because the structure of a city can influence the production of carbon emissions
- decarbonisation linked to climate change, because the reduction of greenhouse gas emissions mitigates climate change effects
- decarbonisation connected to green infrastructure, as their employment serves as a means to achieve decarbonisation

As regards community mapping, it can be defined as a way to make citizens express their views on the development of their neighbourhood.

Figure 7. Community mapping of Ravacciano neighbourhood.

It is a set of approaches and techniques that combines the tools of modern cartography with participatory methods to record and represent the spatial knowledge of local communities.
The students were divided into three groups working together on two qualitative exercises:
The first one had a more graphical aspect: in order to set an urban scenario for the neighbourhood of Ravacciano using a satellite map, we asked students to highlight three main features of the area: barriers (natural and artificial), connections (ecological, mobility and visual) and key elements (criticalities and values).
The second one was a more critical thinking exercise: we asked students to develop a SWOT analysis in terms of landscape perception and interpretation.

Figure 8. SWOT Analysis of Ravacciano neighbourhood.

The overall result was positive: the students gained critical knowledge of the area; they improved their skill in recognizing the urban environment they live in. Without prior knowledge of the area, they were able to interpret maps and read the urban space and its features.

IRENA and MIEMA

List of delegates:
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The exercise with the students was divided into seven tasks, each following and complementing the previous one. Students were divided into three groups. Each group consisted of five members. The first task was to select a target building or a target zone. Each group was asked to select a different building type or a group of buildings within the neighbourhood of Ravacciano or Siena area. The first group had to select a school building, the second group an office building or commercial premises and the third group had to select a residential area (a block of apartments or a group of houses in a street). The second task was the identification of main energy consumers within the building/s chosen and to list the three highest energy consumers according to their opinion and to explain why they have chosen them. The third task was related to the proposal of energy efficiency or renewable energy interventions. Based on the highest energy consumers identified as part of the second task, each group was asked to propose what energy efficiency measures that may be implemented in the building/set of buildings to reduce the consumed energy and improve the energy performance of the buildings. Depending on the building characteristics, students were asked also to propose any renewable energy technologies that can be included. The fourth task was focused on detecting possible challenges that will make the energy improvement difficult both for the energy efficiency measures and renewable energy sources (financial, social, legal or technical barriers to energy renovation). In the fifth task, based on the challenges and barriers identified, students had to propose solutions to overcome the challenges. A more practical task was the sixth one which was related to the estimation of CO_2 reduction through the installation of photovoltaic (PV) panels on the selected building. Each group was asked to measure the area that can be used for the installation of PV on the selected building/group of buildings through Google Maps. Then they had to estimate the size of the PV system that can be fitted on to the roof (kWp), calculate the potential energy generated yearly and at the end, calculate the possible reduction in CO_2 emissions by using the excel tool developed by the University of Siena. Each group prepared a short presentation with all the results of the above-mentioned tasked and present them to the professors and the audience of the workshop.
The first group selected a primary school located at the centre of the Ravacciano neighbourhood and identified the heating system, lighting and electrical equipment and water as the highest energy consumers within the building. Proposals for energy efficiency improvement / RES included heating controls, double glazed windows, wall insulation, LED lighting, use of electronics equipment with a high energy class, water saving taps and the installation of PV on the roof as well as PV shading devices in the playground of the school. The main barriers identified were lack of funds, technical problems with the installation of

new systems, disruption related to works and the aesthetic impact of PV installations. Proposed solutions included the use of funds or grants, carrying out a structural assessment of the building prior to the start of works, carry out works during holidays and carrying out a campaign to educate the residents on the benefits of PV systems.

The second group focused on a shopping centre and the main energy consumers identified included escalators, HVAC systems, water, automatic doors, refrigeration, lighting and gas. Proposed solutions included roof mounted PV system, automatic doors on refrigerators, using waste for the production of biogas, heat pumps and rainwater collection. Barriers to energy renovation included lack of energy awareness, lack of funds and the fact that a good part of the building envelope area is glass. Awareness campaigns, incentives and crowdfunding and the replace of glass with alternative building materials were presented as possible solutions to overcome the barriers.

The third group studies a set of 5 adjacent houses. The highest energy consumers in this case were electrical equipment and heating and domestic hot water. Proposed energy conservation measures included PV panels, LED lighting, micro-wind technologies, solar water heaters, roof insulation and infiltration control. The setting up of a community micro-grid was also proposed. Identified barriers were related to lack of awareness among the residents, investment cost and the visual impact. Similarly to the previous groups, proposed solutions included awareness campaigns, government assistance / tax credits and the use of technologies with a low visual impact.

The presentations of all three groups showed that the students obtained a good understanding of energy efficiency and renewable energy within the urban context and how to identify the correct solutions for different building categories. A particularly important point that was highlighted is the importance of focusing on buildings located in the urban areas, both in terms of energy efficiency improvement as well as for the installation of renewable energy technologies in the buildings to minimise the use of green areas for energy production.

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