

# Italian Cities SDGs Composite Index

A Methodological Approach to Measure the Agenda 2030 at Urban Level

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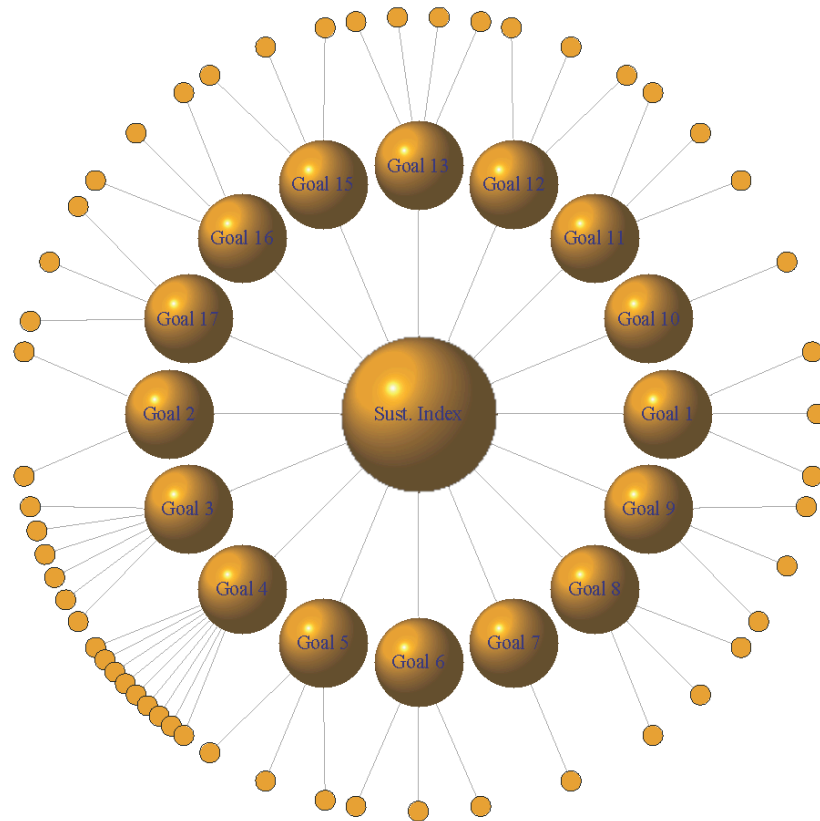
New York, September 26 - 28, 2018

# Outline

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- Data Normalization in the context of SDGs
- Weighting and Aggregation
  - ❖ Variance of elementary indicators
  - ❖ Correlation among elementary indicators
    - ✓ Principal Component
- Results
- Overall Influence of indicators on the composite index

# Composite Index Structure



## Composite Index structure

- 16 SDGs Dimensions
- 53 Elementary Indicators
- 98 Municipalities evaluated

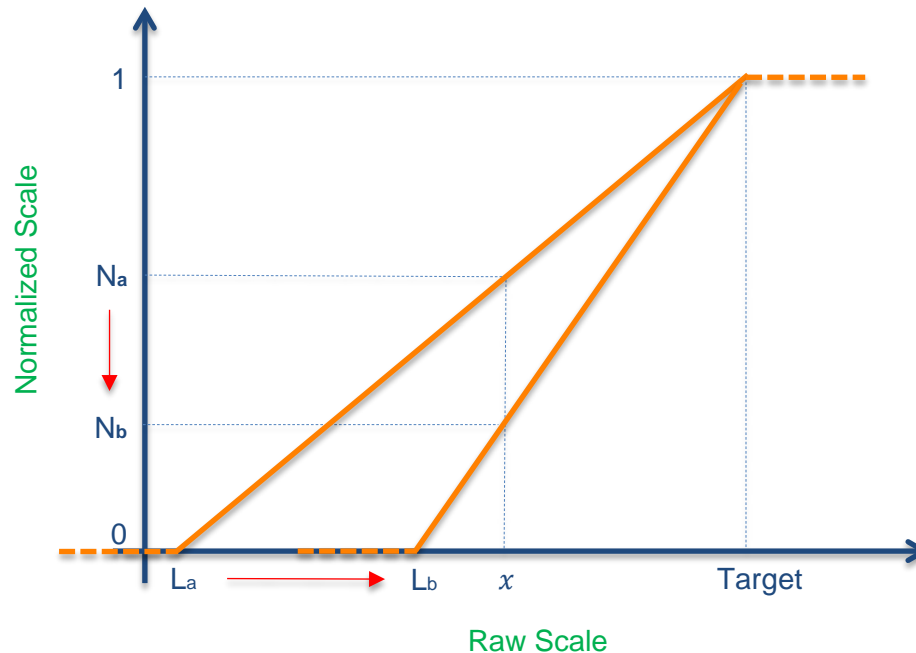
## Computation techniques

- Two levels approach; first within, then between dimensions.
- Standardized Data
- Additive aggregation within and between Dimensions (PC technique)

# Data Normalization/Standardization

# Distance to SDGs Target

- Given a Target (**sustainable level**), the choice of the lower bound (**unsustainable level**) plays a **crucial** role in the measurement of the distance of a point  $x$  to such target.
- The unsustainable level (as the target in some cases) **should not depend on the data** (2.5° percentile, average of the worst  $n$  elements), especially when we compare realities that are **homogeneous**, i.e. cities or regions belonging to the same country, or countries with similar wellbeing level (OECD, etc.)



# Weighting and Aggregation

## Principal component Technique

## Example

$$\mathbf{R}_x = \mathbf{A}\mathbf{\Lambda}\mathbf{A}' = \begin{bmatrix} 1 & 1 & 0 \\ 1 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\mathbf{z} = \mathbf{A}'\mathbf{x}$$

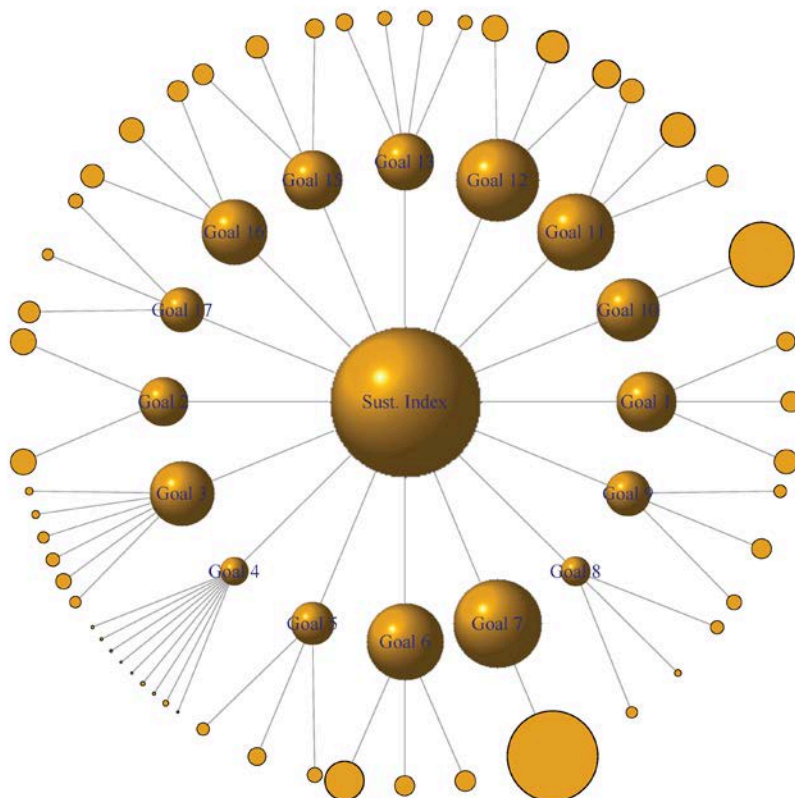
$$\mathbf{A} = \begin{bmatrix} 0.7 & 0 \\ 0.7 & 0 \\ 0 & 1 \end{bmatrix}; \quad \mathbf{\Lambda} = \begin{bmatrix} \lambda_1 & 0 \\ 0 & \lambda_2 \end{bmatrix} = \begin{bmatrix} 2 & 0 \\ 0 & 1 \end{bmatrix}; \quad \mathbf{B} = \begin{bmatrix} 0.5 & 0 \\ 0.5 & 0 \\ 0 & 1 \end{bmatrix}$$

- OECD technique  $\mathbf{w} = \frac{\lambda_1}{3}\mathbf{b}_1 + \frac{\lambda_2}{3}\mathbf{b}_2 = [1/3 \quad 1/3 \quad 1/3]'$
- It is not recommended the technique that fits the **data** best, but the one that best fits the **dimensions** the data are explaining, in which indicators that are statistically independent are weighted more than those that belong to the same dimension:

$$\mathbf{w} = \text{rowmean}(\mathbf{B}) = [1/4 \quad 1/4 \quad 1/2]'$$

$$\mathbf{y} = \mathbf{w}'\mathbf{x}$$

# Weights of SDGs

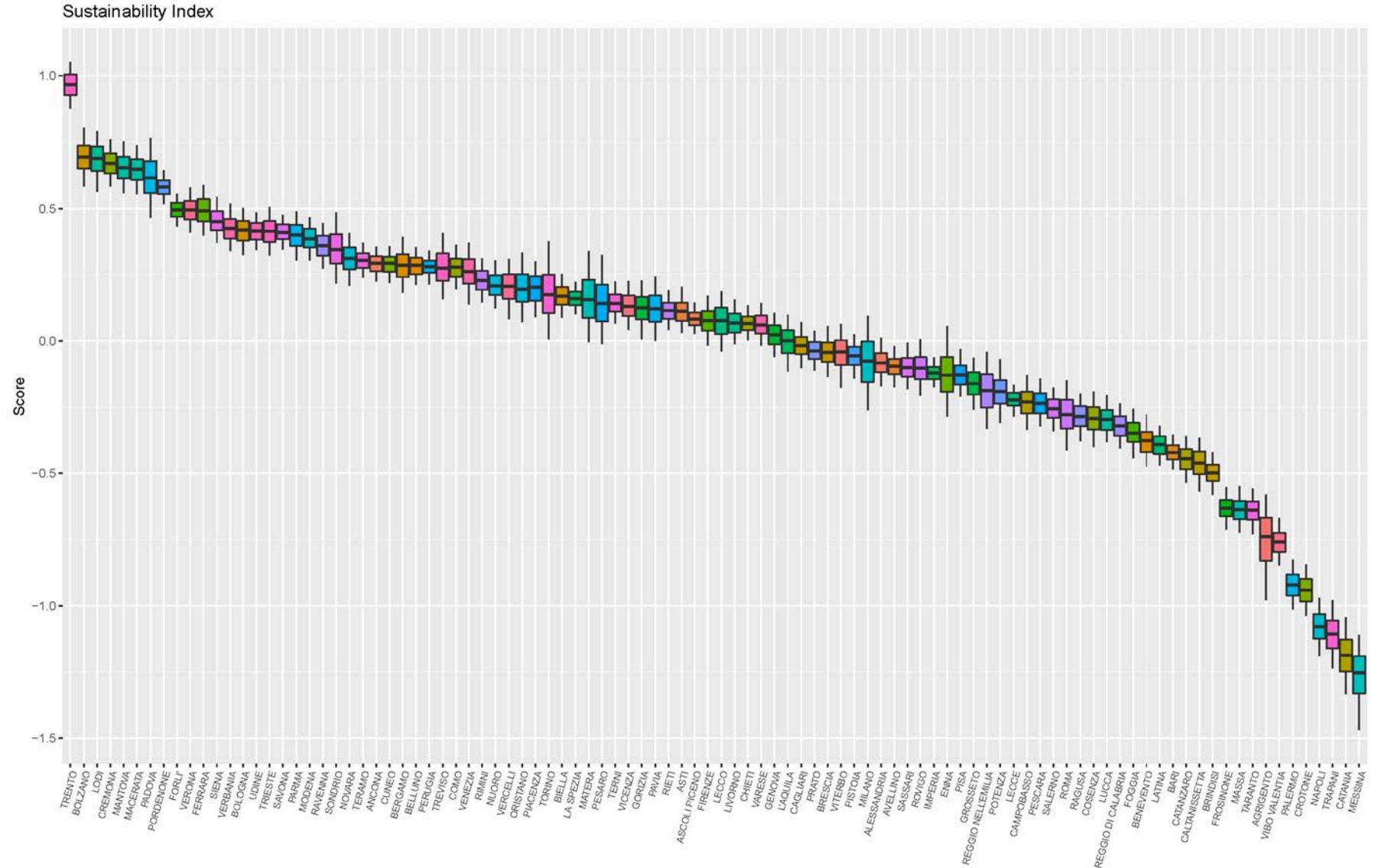


Description	Goal	Weight
Affordable and Clean Energy	Goal 7	9.49%
Responsible Consumption and Production	Goal 12	8.71%
Sustainable Cities and Communities	Goal 11	8.31%
Clean Water and Sanitation	Goal 6	8.17%
Peace, Justice and Strong Institutions	Goal 16	6.96%
Good Health and Well-Being for People	Goal 3	6.94%
Reducing Inequalities	Goal 10	6.74%
No Poverty	Goal 1	6.40%
Life on Land	Goal 15	6.36%
Climate Action	Goal 13	6.16%
Zero Hunger	Goal 2	5.25%
Industry, Innovation, and Infrastructure	Goal 9	4.87%
Partnerships for the Goals	Goal 17	4.84%
Gender Equality	Goal 5	4.59%
Decent Work and Economic Growth	Goal 8	3.17%
Quality Education	Goal 4	3.04%

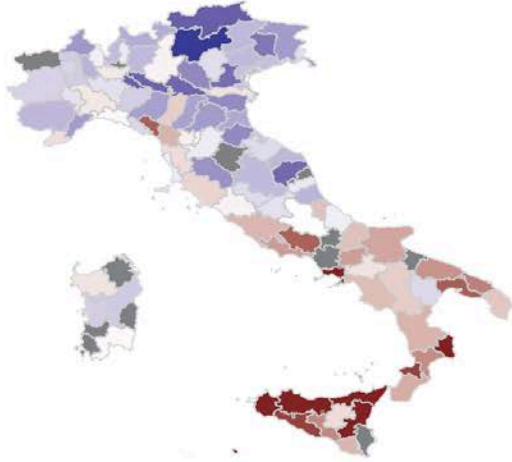


# Results

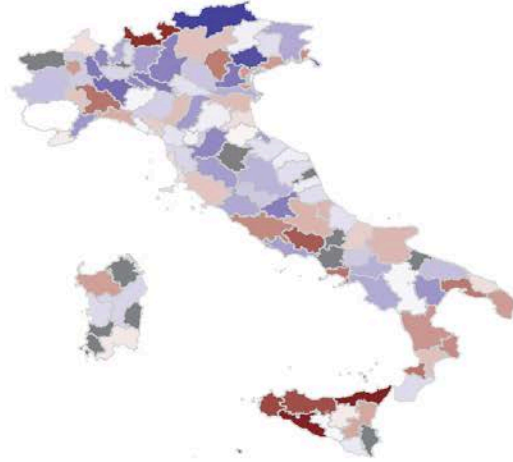
# Bootstrap



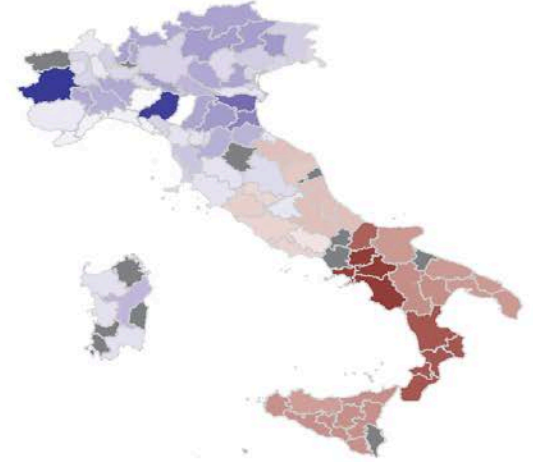
Sustainability Index



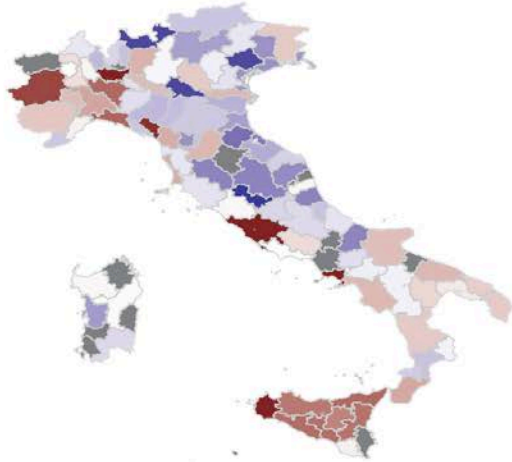
Goal 1



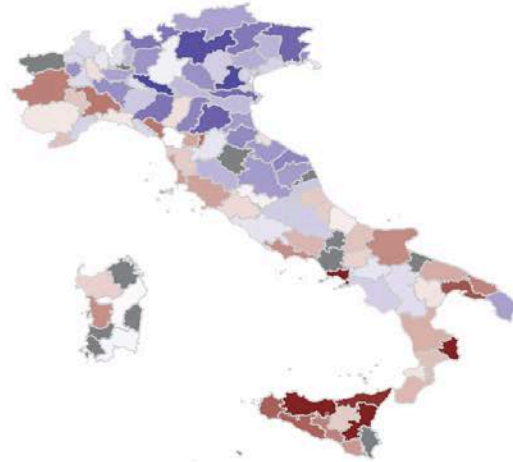
Goal 2



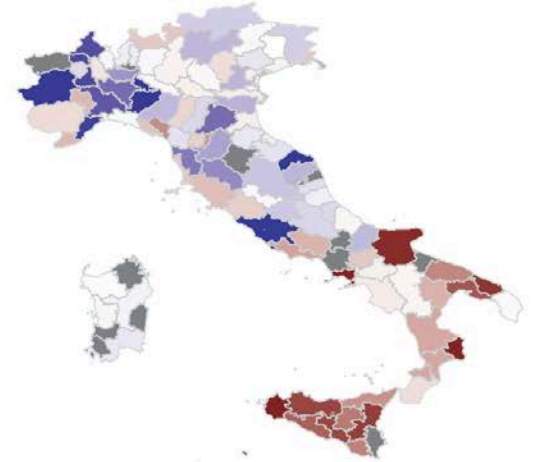
Goal 3



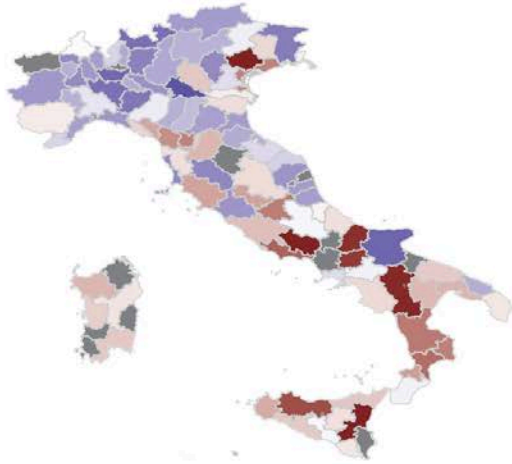
Goal 4



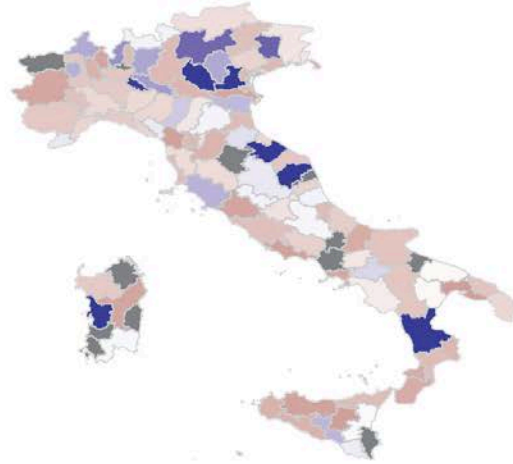
Goal 5



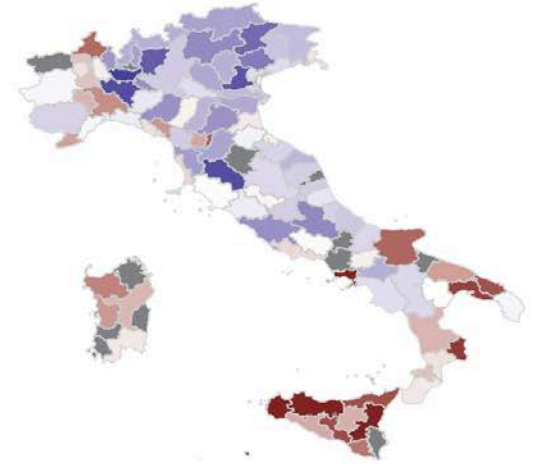
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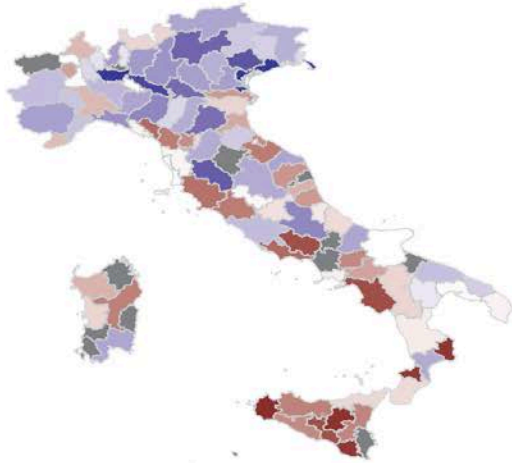
Goal 7



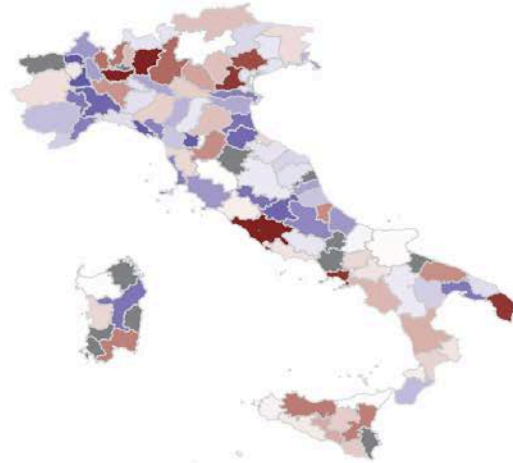
Goal 8



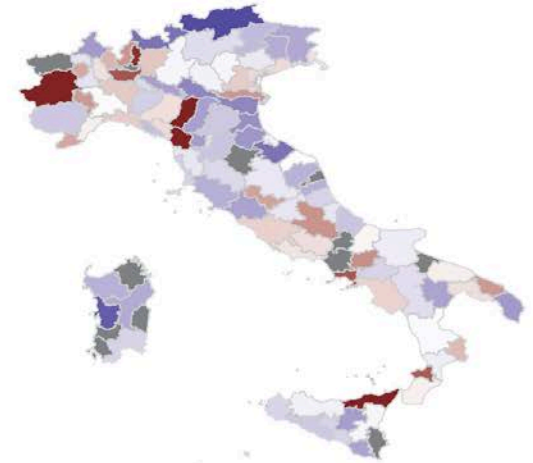
Goal 9



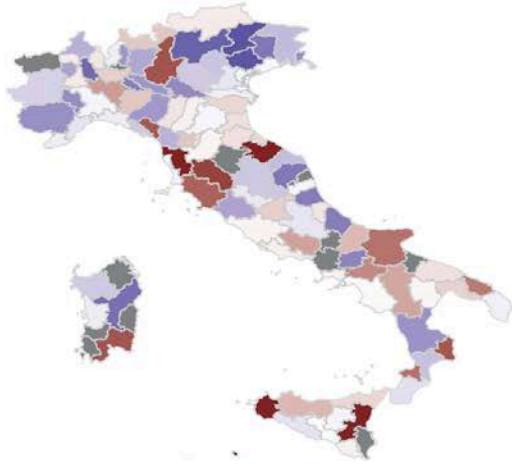
Goal 10



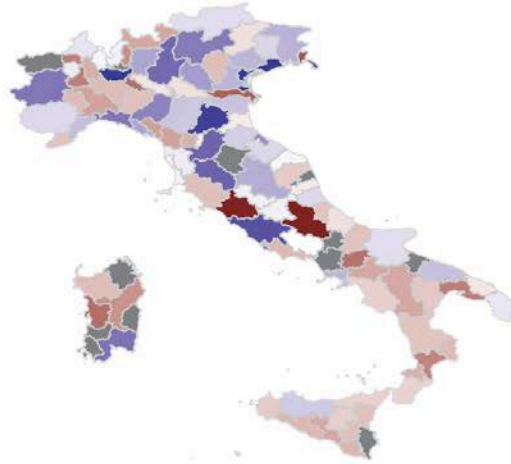
Goal 11



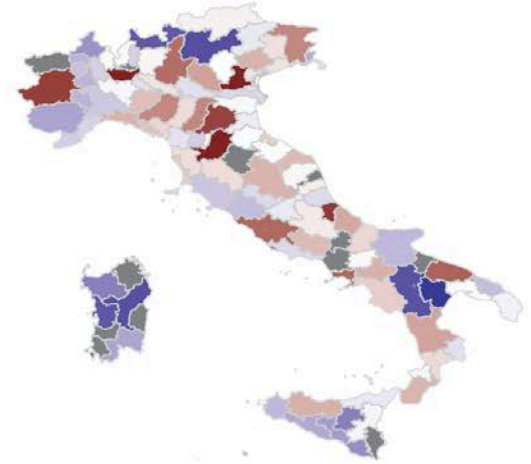
Goal 12



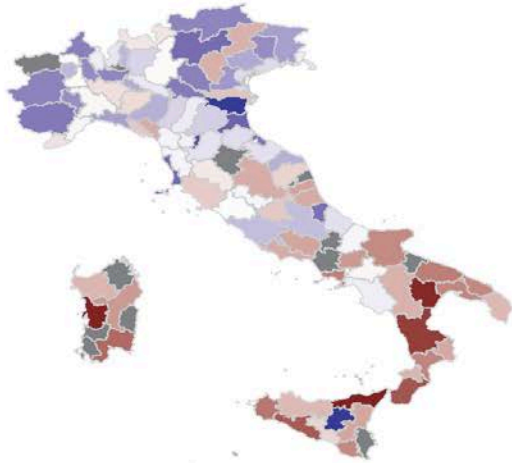
Goal 13



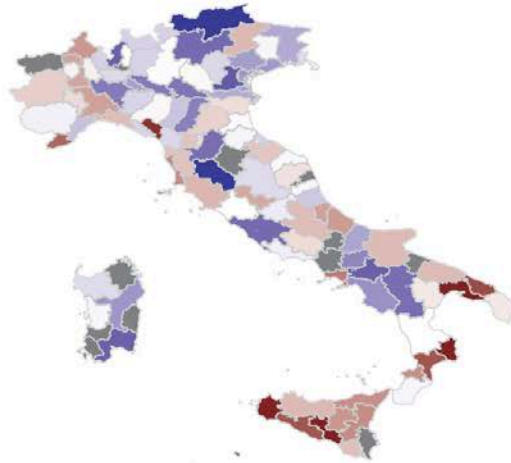
Goal 15



Goal 16



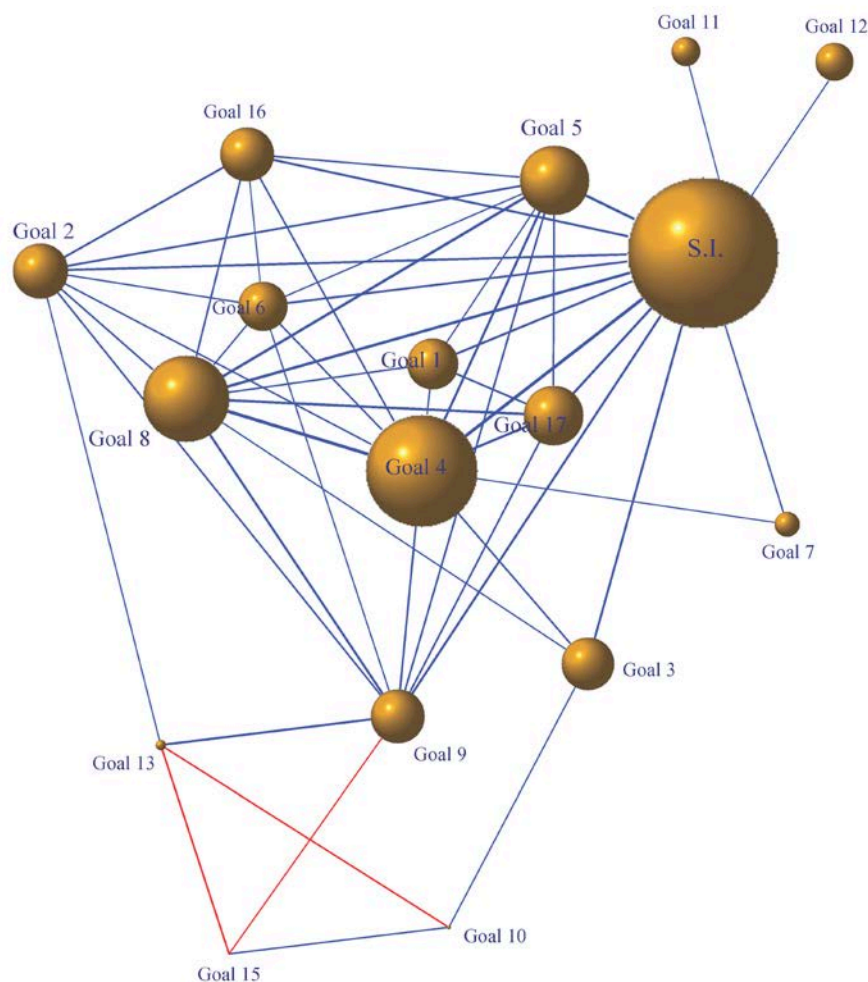
Goal 17



# Overall Influence of Indicators

# Influence of SDGs on Sustainable Index

$$Influence_{x_i,y} = cor^2(x_i, y)$$



Description	Goal	Influence
Quality Education	Goal 4	14.80%
Decent Work and Economic Growth	Goal 8	11.15%
Gender Equality	Goal 5	9.25%
No Poverty	Goal 1	8.30%
Zero Hunger	Goal 2	8.14%
Partnerships for the Goals	Goal 17	7.63%
Peace, Justice and Strong Institutions	Goal 16	7.24%
Good Health and Well-Being for People	Goal 3	6.85%
Industry, Innovation, and Infrastructure	Goal 9	6.59%
Clean Water and Sanitation	Goal 6	6.08%
Responsible Consumption and Production	Goal 12	4.82%
Sustainable Cities and Communities	Goal 11	3.47%
Affordable and Clean Energy	Goal 7	3.40%
Climate Action	Goal 13	1.58%
Reducing Inequalities	Goal 10	0.69%
Life on Land	Goal 15	0.02%

# Conclusions

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- There is the need of internationally recognized thresholds of sustainability (especially **unsustainable levels**):
  - ➔ Composite index has an unbiased, direct and clear **interpretation**.
- PC (with equal weights given to components) is a good approach to balance the structure of the data.
- To better understand which dimensions play a central role in the composite index, their influences ( $\neq$  weights) on the composite index should be evaluated.



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**Thank you**

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# Extra Slides

# Elementary Indicators

Indicator	SDGs	Polarity
Elderly people dependence index	1	negative
Economic distress	1	negative
Individuals in low-working intensity families	1	negative
Urban bio gardens	2	positive
Obesity rate	2	negative
Healthy life expectancy at birth	3	positive
Healthy life expectancy at 65 years	3	positive
Deaths and injuries in road accidents	3	negative
Support to elderly people	3	positive
Suicide rate	3	negative
Infant mortality rate	3	negative
Nursery services for children aged 0-36	4	positive
Student literary competence	4	positive
Student numerical competence	4	positive
People with university degree	4	positive
Population with low school license (isced 3)	4	positive
Enrolled population at school aged 0-16	4	positive
Schools with ramps for people with disabilities	4	positive
School with technologies	4	positive
Population with pre-university education	4	positive
Employment gender balance	5	positive
Woman mayor in the last 10 years	5	positive
Women educational level compared to men	5	positive
Water losses	6	negative
Population connected to urban waste water treatment plants	6	positive
Population served by sewerage	6	positive
Solar PV installed	7	positive

Indicator	SDGs	Polarity
Average taxable income per capita	8	positive
Neet (15-29)	8	negative
Youngs aged 18-24 not enrolled in any educational course	8	negative
Public transportation availability	9	positive
Green firms	9	positive
Connection infrastructure	9	positive
Gini index	10	negative
Cycling road	11	positive
People with no toilet	11	negative
Pm 2.5 emission	11	negative
Recycled waste	12	positive
Urban waste	12	negative
Incentive to recycling garden waste	12	positive
Public transportation mobility	13	positive
Bike sharing	13	positive
Propensity to public transportation	13	positive
CO2 emission	13	negative
Share area utilization	15	negative
Green urban areas per population	15	positive
Ecolabel licenses	15	positive
Political electoral participation	16	positive
Tribunal efficiency	16	negative
Firms rating	16	positive
Broadband penetration rate	17	positive
Propensity to association	17	positive
Social cooperatives	17	positive

# Weights of Indicators

$$\mathbf{R} = \mathbf{A}\mathbf{\Lambda}\mathbf{A}'$$

$$\mathbf{z} = \mathbf{A}'\mathbf{x}$$

$$\mathbf{B} \text{ (with } b_{ij} = a_{ij}^2\text{)}$$

$$\mathbf{w} = \text{rowmean}(\mathbf{B})$$

$$C = \left\{ k \mid \underset{k}{\operatorname{argmin}} f(k) = \left\lfloor \sum_{i=1}^k \lambda_i - 0.85 \cdot p \right\rfloor, k = \{1, \dots, p\} \right.$$

$$D = \{v \mid \lambda_v \geq 1\}, \quad v = \{1, \dots, p\}$$

$$d^* = \max(k, v)$$

$$\mathbf{y} = \mathbf{w}'\mathbf{x}$$