Improving the WALKABILITY for Next-Generation Cities and Territories, through the Reuse of Available Data ad Raster Analysis

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W A L K ABILITY

LINKS
SMB SiTI

DIST
Dipartimento Interateneo
di Scienze, Progetto e Politiche del Territorio

LARTU

S3+lab
urban Sustainability & Security laboratory for Social challenges

SOCIAL SUPPORT

AIR POLLUTION

RECREATIONAL FACILITIES

QUALITY OF ROUTES

CULTURAL ACTIVITIES

AESTHETICS

SHOPS AND MALLS

GREEN AREAS

QGIS Viewer; Image source: Google Satellite

BENEFITS OF

Environment

Community

Individual

Physical health

Emotional wellbeing

Reduced transportation costs

Awareness of place

Increased connectivity

Higher property values

Safer ("eyes on the street")

More vibrant

Increased economic activity

Reduced carbon/ greenhouse gas

Reduced harmful particulates

Reduced brake dust

Less oil consumption

Healthier ecosystems

WALKABLE NEIGHBORHOODS

People / Persone

Walking is good for health
Camminare fa bene alla salute

City liveability
Vivibilità della città

Security
Sicurezza

Walking is pleasant and socializing
Camminare è piacevole e socializzante

Soft mobility
Mobilità dolce

Reduction of pollution (air, noise…)
Riduzione dell'inquinamento (dell'aria, acustico…)

Sustainable mobility
Mobilità sostenibile

Functional mix
Mix funzionale

City / Città

Urban densification
Densificazione urbana

https://purepng.com/public/uploads/large/purepng.com-city-skylinecityctiesskylineskyscrapers-25152016447vrrnd.png

DATA & INFORMATIONS: FEED «WALKABILITY»

AESTHETICS, SMART AND BEAUTIFUL

SIDEWALKS

HEAT ISLAND

QUALITY OF ROUTES

AIR POLLUTION

FUN AND RELAXING

TRAFFIC FATALITIES

TRAFFICLIGHTS

ROAD SAFETY
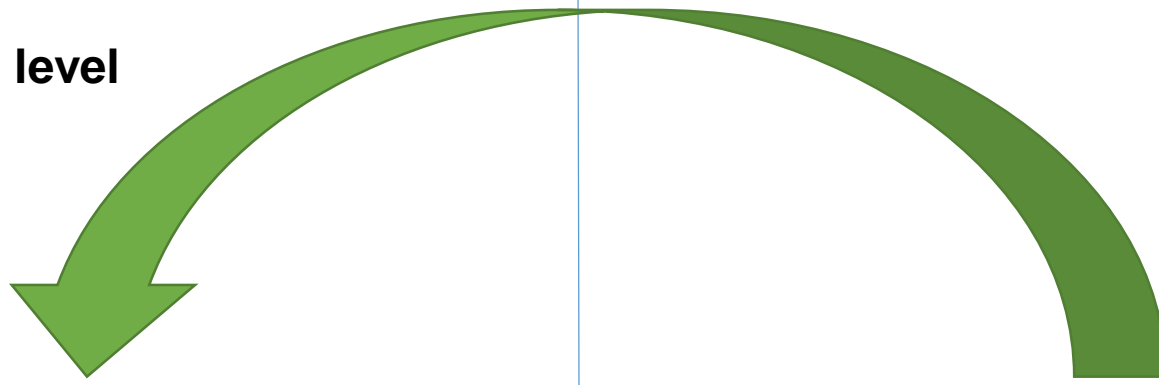
HEALTH

EASY TO CROSS

CRIME SECURITY

WALKSTRIPES

The footpath network - that is built from car traffic free streets, sidewalks, crossings, and subways - has a coverage that differs from the street network
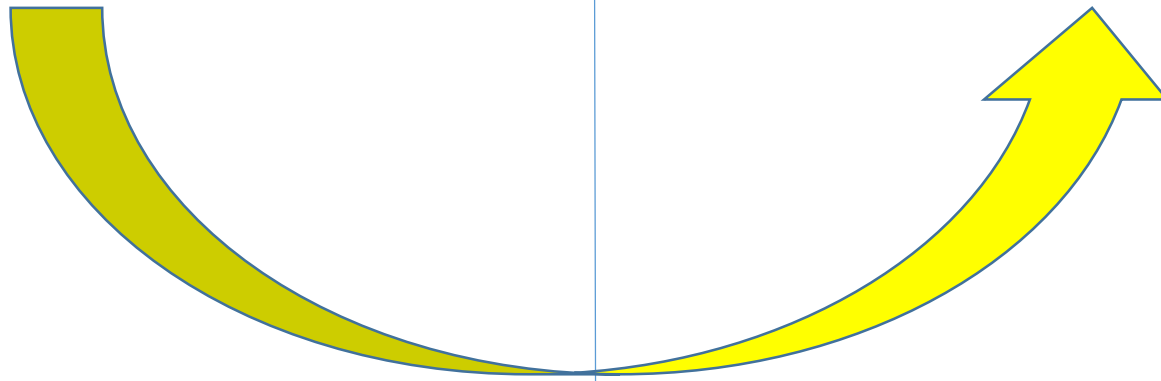
Neighborhood level

Livello «quartiere»

City level

Livello «città»

Analysis and evaluation of walkability

Recognize the parts of cities where actions to improve walkability can be more effective

Analisi e valutazione della walkability

Riconoscere le parti di città dove azioni per il miglioramento della walkability possono essere più efficaci

Analysis of "walkability" in literature

Le analisi della walkability presenti in letteratura

Critical issues

Criticità

➡ * (often) they **do not use specific «graphs» related to mobility on foot** (because there are **no pedestrian path graphs**)

* spesso non fanno uso di grafi specifici relativi alla mobilità a piedi (perché non esistono grafi dei percorsi pedonali)

➡ * (often) they involve **field analysis (very expensive)** and therefore **on small portions of territory**

* spesso prevedono analisi sul campo (molto onerose) quindi su porzioni ridotte di territorio

ITDP, Institute for Transportation and Development Policy (2018) - New York www.itdp.org

"Walkability Hierarchy of Needs Pyramid": 6 general and compact criteria in 3 macro indexes: **feasibility**, **safety** and **confort / pleasure**

## City and/or metropolitan area: recognizing parts where actions to improve walkability are most effective

Livelli di analisi/intervento1 - livello città / area metropolitana: riconoscere le parti di città dove azioni per il miglioramento della walkability sono più efficaci

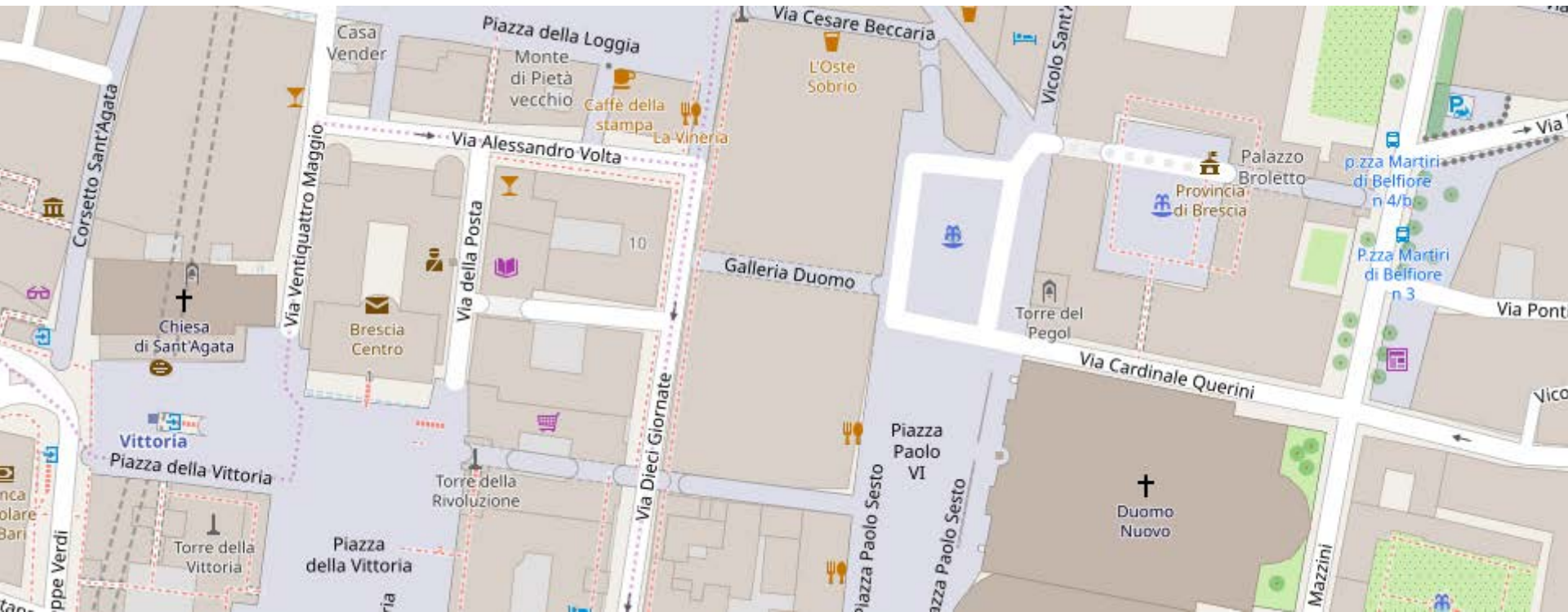## Neighborhood level: walkability analysis and evaluation

Livello neighborhood: analisi e valutazione della walkability

Single street level: design checklist
Livello singola strada: checklist per la progettazione
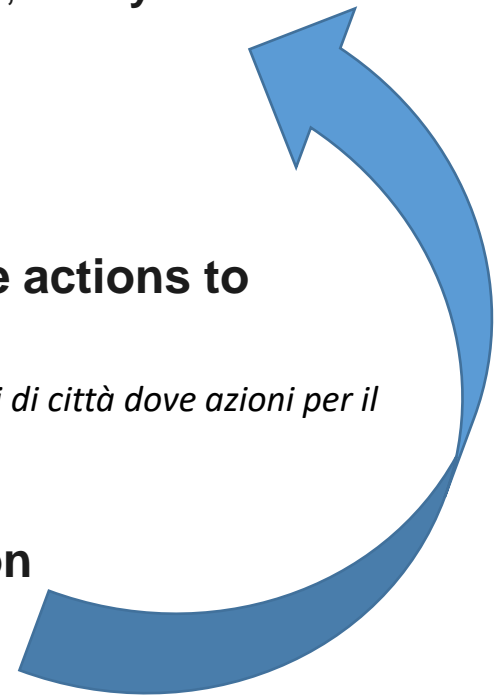
Neighborhood level

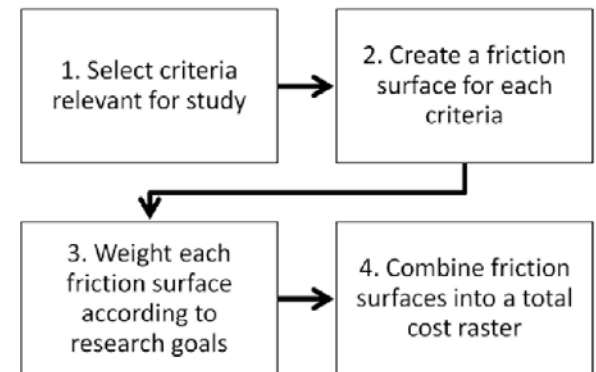# ArcGIS vs QGIS: *proprietary vs free software*

The «raster analysis»: some definitions

A **cost raster (local cost)** is a raster object with cell values that represent a price per distance unit; for example, monetary expenditure per meter, fuel usage per mile, traversal time per mile, and so forth.

A cost distance calculates the least accumulative cost distance for each cell from or to the least-cost source over a cost surface. Cost Distance explores the movement of a traveler over a landscape. The cost distance tools are generally used to create the least-cost path or corridor between a source and a destination.

The **Kernel Density** tool calculates the density of features in a neighborhood around those features. It can be calculated for both point and line features.

A (network) **service area** is a region that encompasses all accessible streets (within a specified impedance). For instance, the 5-minute service area for a point on a network includes all the streets that can be reached within five minutes (from that point).

1. Select criteria relevant for study → 2. Create a friction surface for each criteria

3. Weight each friction surface according to research goals → 4. Combine friction surfaces into a total cost raster

This image from (*)

Building the «COST RASTER»
Costruzione del «COST RASTER»

Other datasets used?
Altri datasets utilizzati?

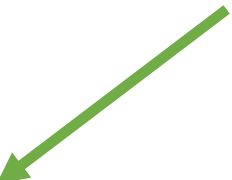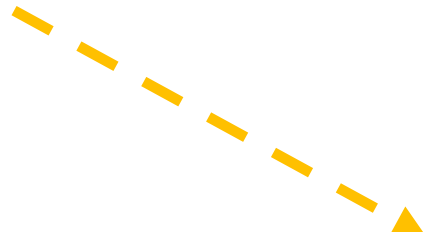Criteria
Criteri

Datasets available
Dataset disponibili

Indicators
Indicatori

Indices
Indici

Cost Raster: impedance to walk the cell on foot (completion at 100 of the weighted sum of the macro-indices)

Cost Raster: impedenza a percorrere la cella a piedi, completamento a 100 della somma pesata dei macro-indici

Summary macro index	Macro index			Index		
	Weigh attributed to the weighted sum	Name	Descritpion	Weigh attributed to the weighted sum	Name	Description
COST RASTER: impedance to walk the cell on foot, complement to 100 of the weighted sum of the macroindices	40%	I_NPER	Feasibility (possibility of moving on foot)	100%	I_NPER_MAR	Presence of sidewalks, pedestrian crossings, paths, slides, stairs ...
						Priority given to the pedestrian movement which minimizes routes and times
	30%	I_NSIC	Safety (physical and antrophic)	20%	I_NSIC_COM	Presence of activities on the pavement level: shops, stalls ...
				20%	I_NSIC_INC	Low number of accidents involving pedestrians
				20%	I_NSIC_SEM	Presence of intersections with vehicular roads regulated by traffic lights
				40%	I_NSIC_SEP	Separation of pedestrian paths / vehicular routes
						Presence of zones and intersections with controlled traffic areas
						Confortable lighting levels
						Social control by the people of the houses overlooking the lower floors
	30%	I_NPIA	Comfort / Pleasure	10%	I_NPIA_ALB	Presence of trees
				5%	I_NPIA_ARU	Presence of urban/street furniture
				15%	I_NPIA_COM	Presence of attractive activities at the sidewalk level (shops) = I_NSIC_COM
				10%	I_NPIA_COP	Presence of covered paths
				10%	I_NPIA_EDI	Presence of "buildings of particular historical interest"
				5%	I_NPIA_H2O	Presence of drinking fountains
				10%	I_NPIA_PAV	Paving quality
				15%	I_NPIA_RUM	Low noise level
				15%	I_NPIA_VER	Path adjacent to green areas
				5%	I_NPIA_VIS	Presence of visuals and panoramic points
						Presence of quality lighting
						Presence of artworks

Blu: from CTC

Yellow: Other data (probably available in the future)

White: Georeferenced alphanumeric datasets (points)

Blu: Da CTC   Giallo: Altri dati probabilmente reperibili in futuro   Bianco: Dataset alfanumerici georeferenziati (punti)

| Summary macro index	Macro index			Index		
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Neighborhood Level

Municipal Technical Map (*CTC*) of the City of Turin (nominal scale: 1: 1000). The data set is structured according to the content specifications for the IntesaGIS geotopographic DBs

Carta Tecnica Comunale della Città di Torino (scala nominale 1:1000) Strutturata secondo le specifiche di contenuto per i DB geotopografici IntesaGIS

The "walkable" urban space as modeled using a 1m x 1m raster data set.
Each cell is given an impedance to be traveled on foot

Lo spazio urbano "camminabile" modellato attraverso un raster 1m x 1m.
Ad ogni cella è attribuita una impedenza ad essere percorsa a piedi

Raised crosswalks are safer than non raised ones
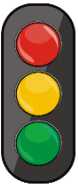
Traffic light scale: red means high impedance, green high walkability...
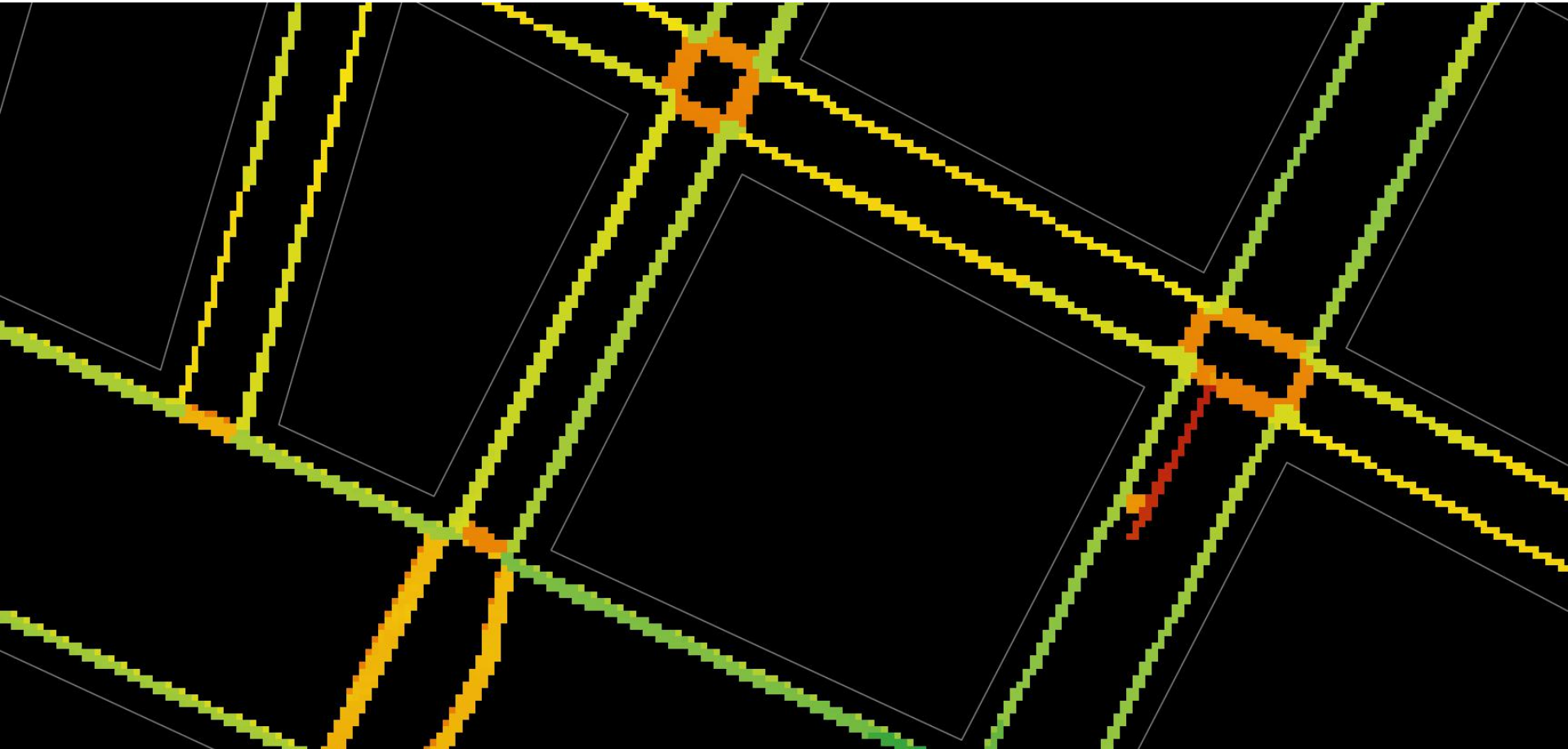
ArcGIS: «COST RASTER»

QGIS: «LOCAL COST»

Building the «COST RASTER» → spatialized data with kernel density estimation

Costruzione del «Cost Raster» → dati puntuali spazializzati con la «kernel density estimation»
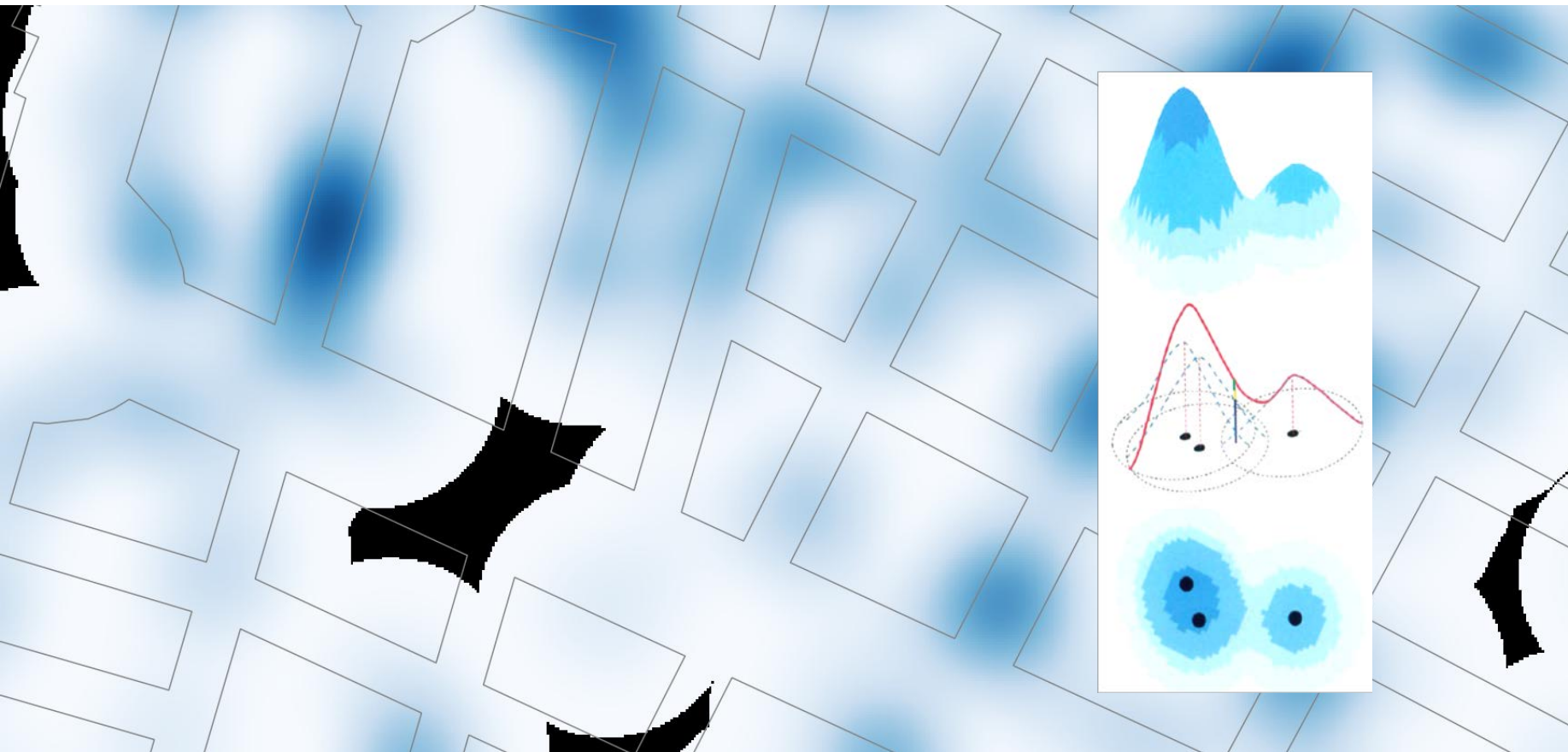
Shops, Malls, Catering Stall   *Attività commerciali ed esercizi pubblici*
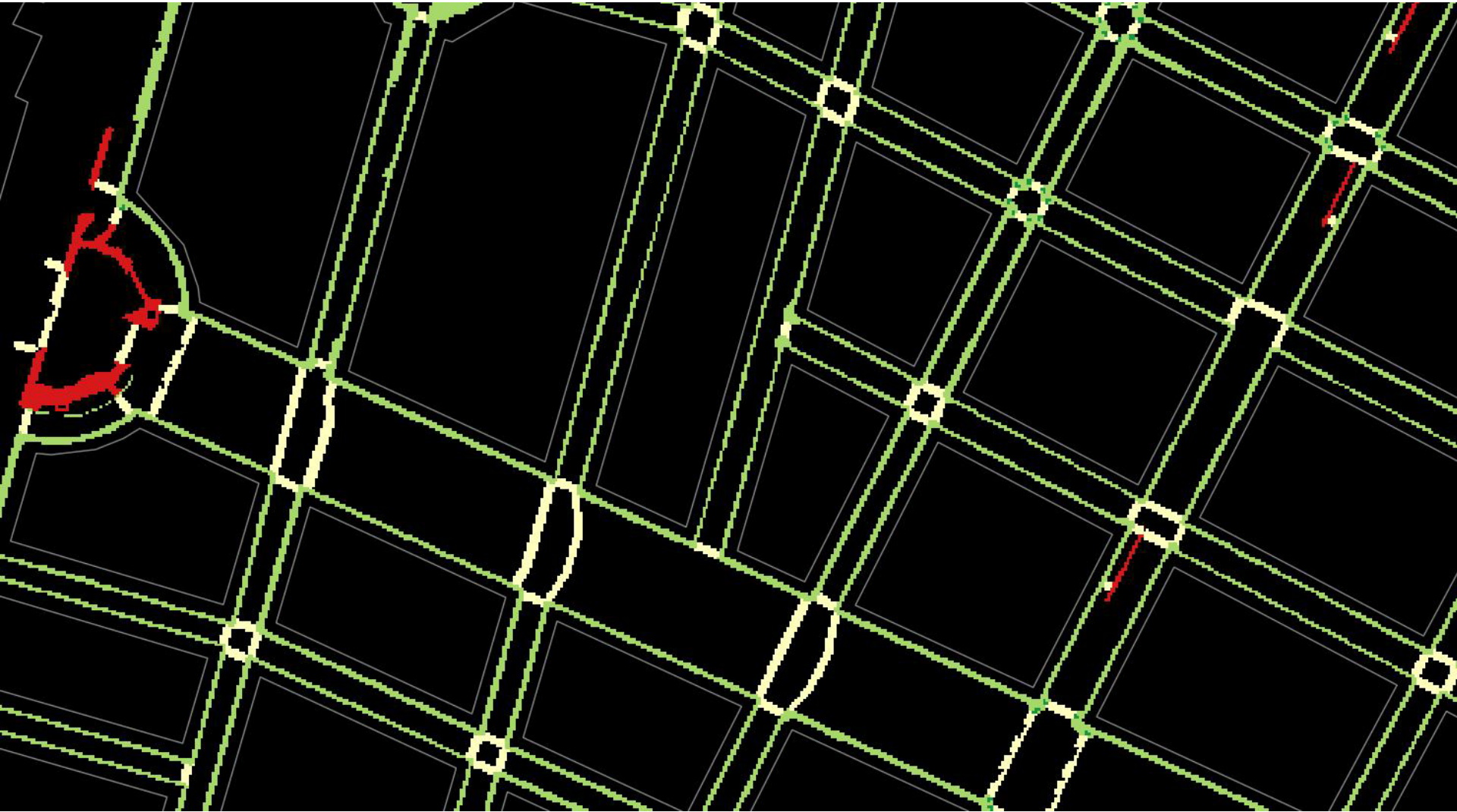
Raster calculator -> Weighted sum

Raster calculator -> Somma pesata

Building the «COST RASTER» - 2° Macro-Index → Safety, security

Costruzione del COST RASTER 2° Macro-indice → Sicurezza
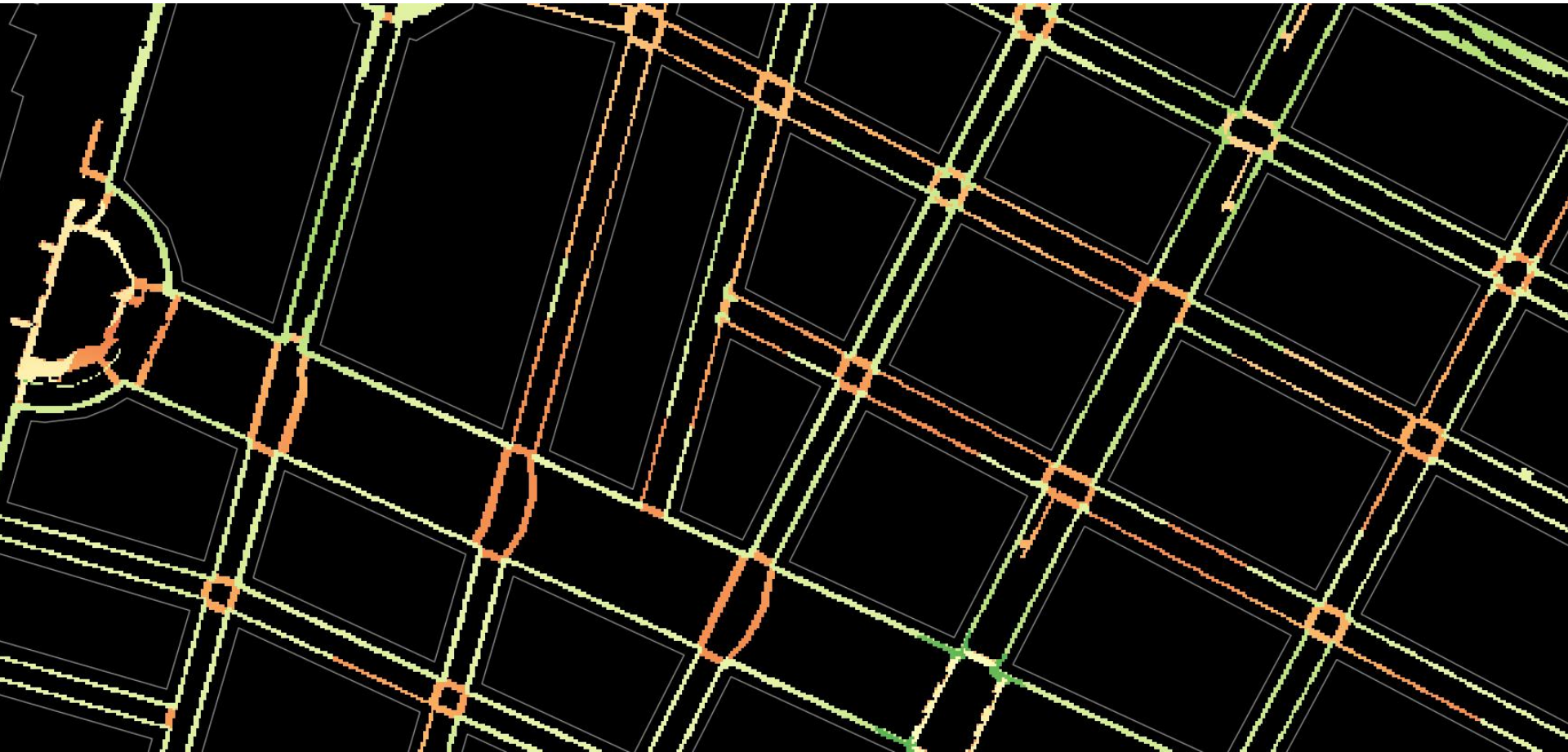
Raster calculator -> Weighted sum

Raster calculator ->   Somma pesata

Building the «COST RASTER» - 3° Macro-Index → Comfort / pleasantness

Costruzione del COST RASTER 3° Macro-indice → Piacevolezza
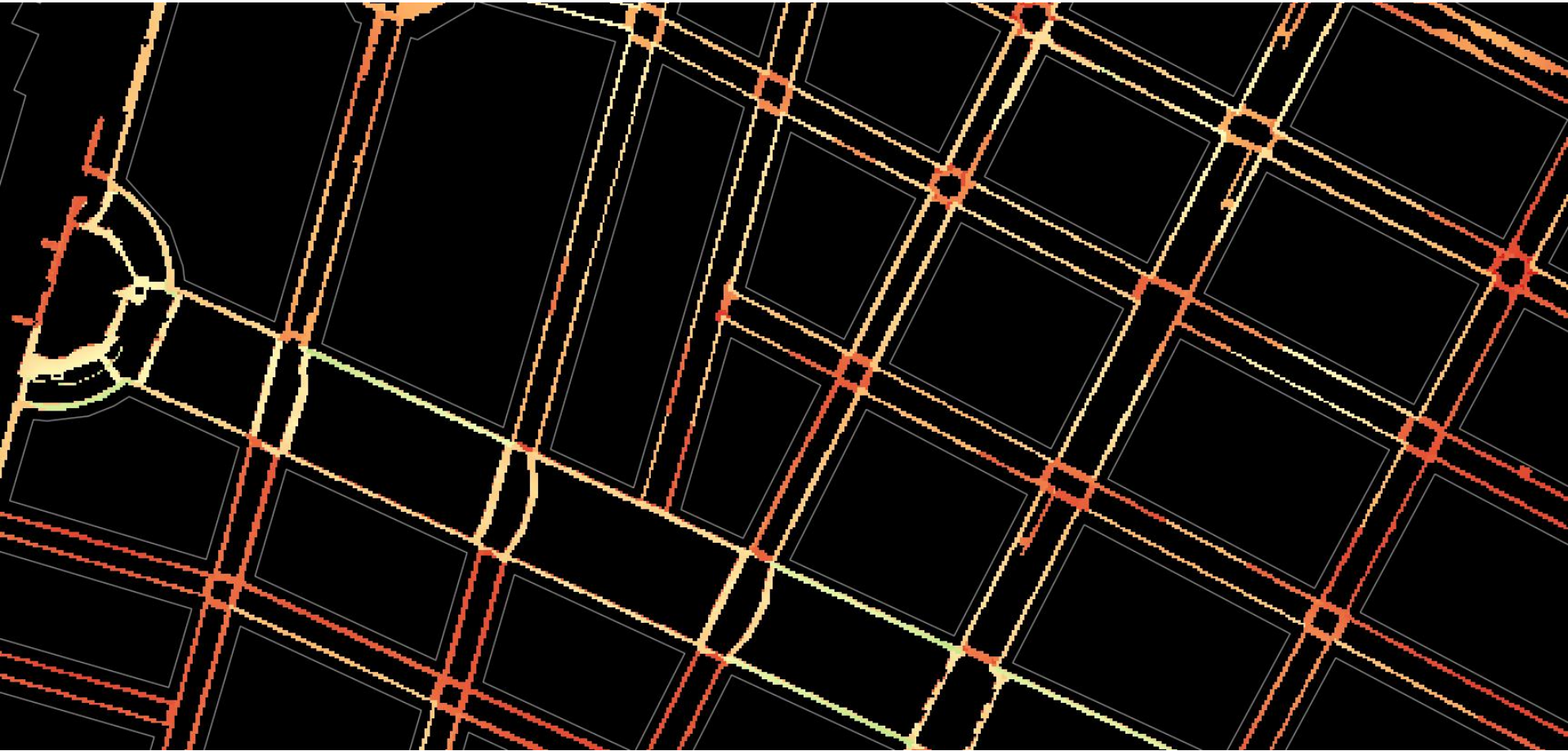
Raster calculator → Weighted sum

Raster calculator -> Somma pesata

COST RASTER → Weighted View of Walkability

COST RASTER → vista pesata della walkability
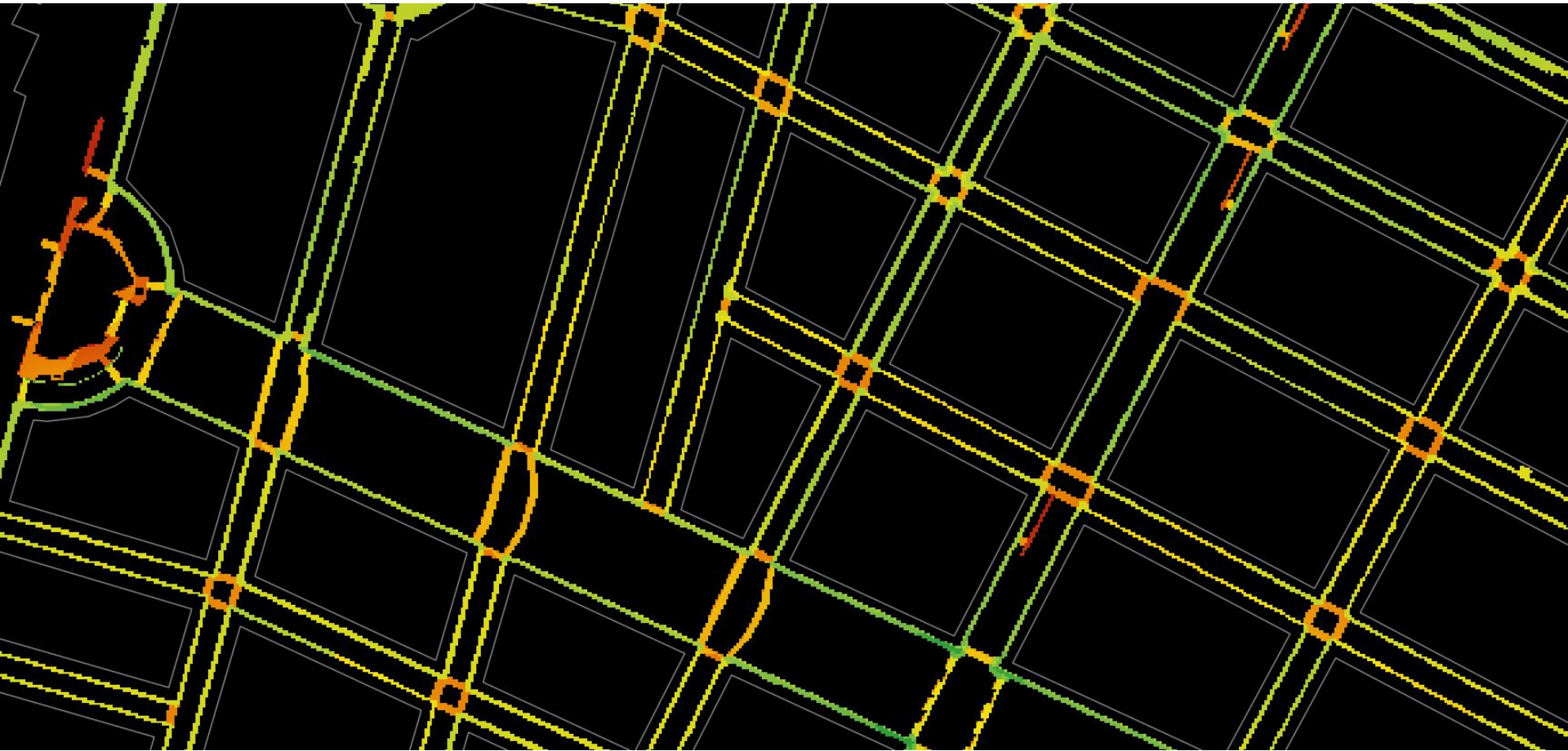
Raster calculator → Weighted sum

Raster calculator → Somma pesata
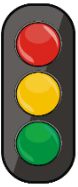
Weighted sum of the cost distance: overall convenience to move on foot towards attractive activities (in a radius of acceptability on foot)

Somma pesata dei «cost distance»: convenienza complessiva a muoversi a piedi verso attività attrattive in un raggio di accebilità a piedi

Neighborhood Level			
Macro index		**Index**	
Weigh attributed to the weighted sum	Cost Distance Raster Name	Weigh attributed to the weighted sum	Attractive Activities / Points of Interest / Urban Opportunities
	Accessibility to schools (3 -14 years old)	20%	Kindergartens
		80%	Primary and secondary schools
	Accessibility to intermodality points in urban mobility	30%	Metro stops
		30%	"Lines of force" stops (bus, tramways)
		20%	Bike sharing stations
		5%	Car sharing stations
		5%	Taxi stations
		10%	Railway stations
			Secondary schools
			Universities
			Hospitals
			Other places of worship
			Churches
			Cinema
			Theaters
			Museums
			Public offices of interest to citizens
			Shopping centers
			Natural shopping centers

Left margin label: Weighted sum of the COST DISTANCE: overall convenience to move on foot towards attractive activities in a radius of accessibility on foot

Right annotations: 2 cost distance (for Kindergartens and Primary and secondary schools); 6 cost distance (for Metro stops, "Lines of force" stops, Bike sharing stations, Car sharing stations, Taxi stations, Railway stations)

Accessibility Analysis: schools (3-14 years old)

ANALISI DELL'ACCESSIBILITA' scuole 3-14 anni

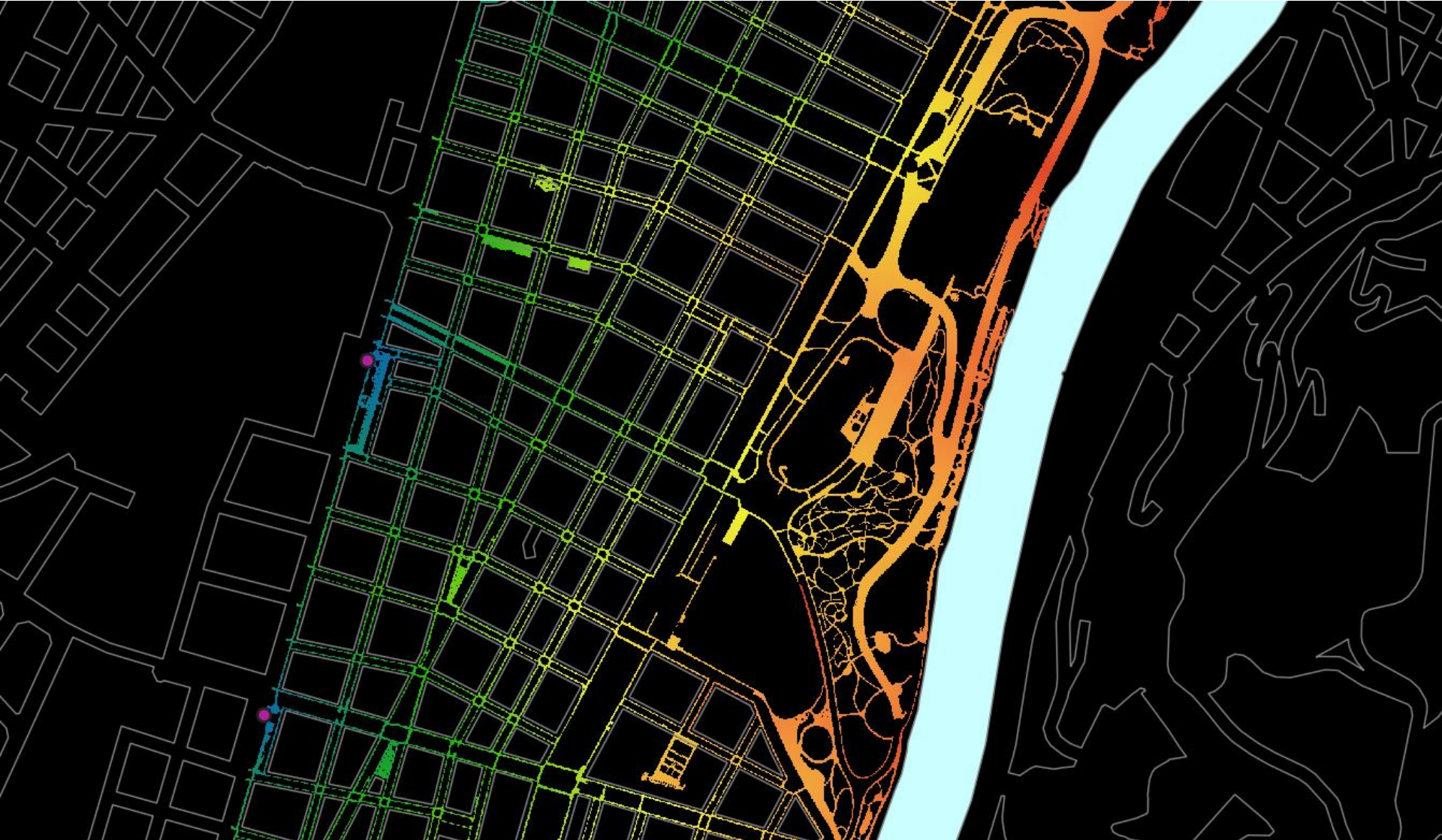Weighted distance using the COST RASTER

Distanza pesata utilizzando il COST RASTER

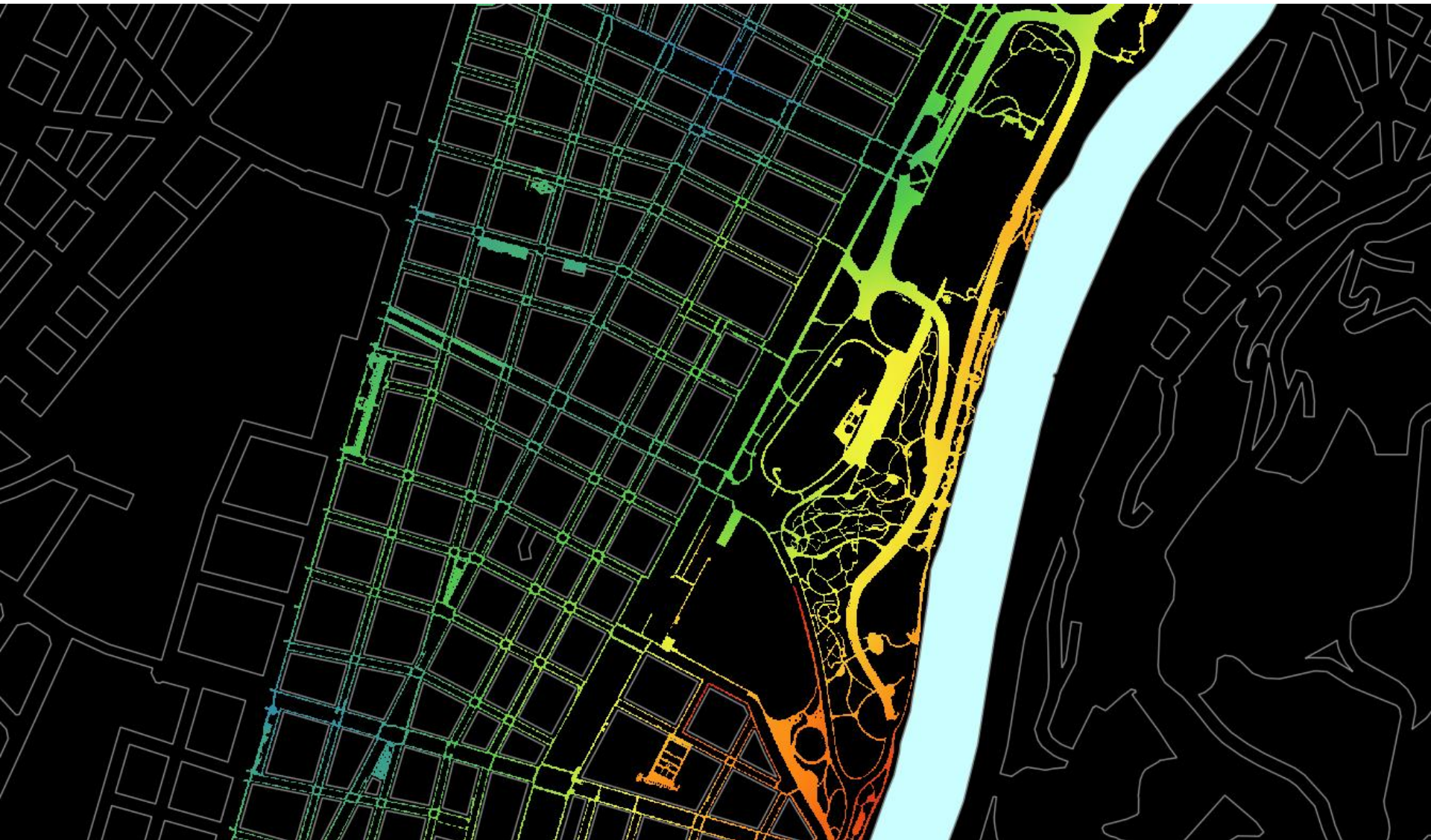«COST DISTANCE» (ArcGIS)

«CUMULATIVE COST» (QGIS)

Accessibility Analysis: subway stops

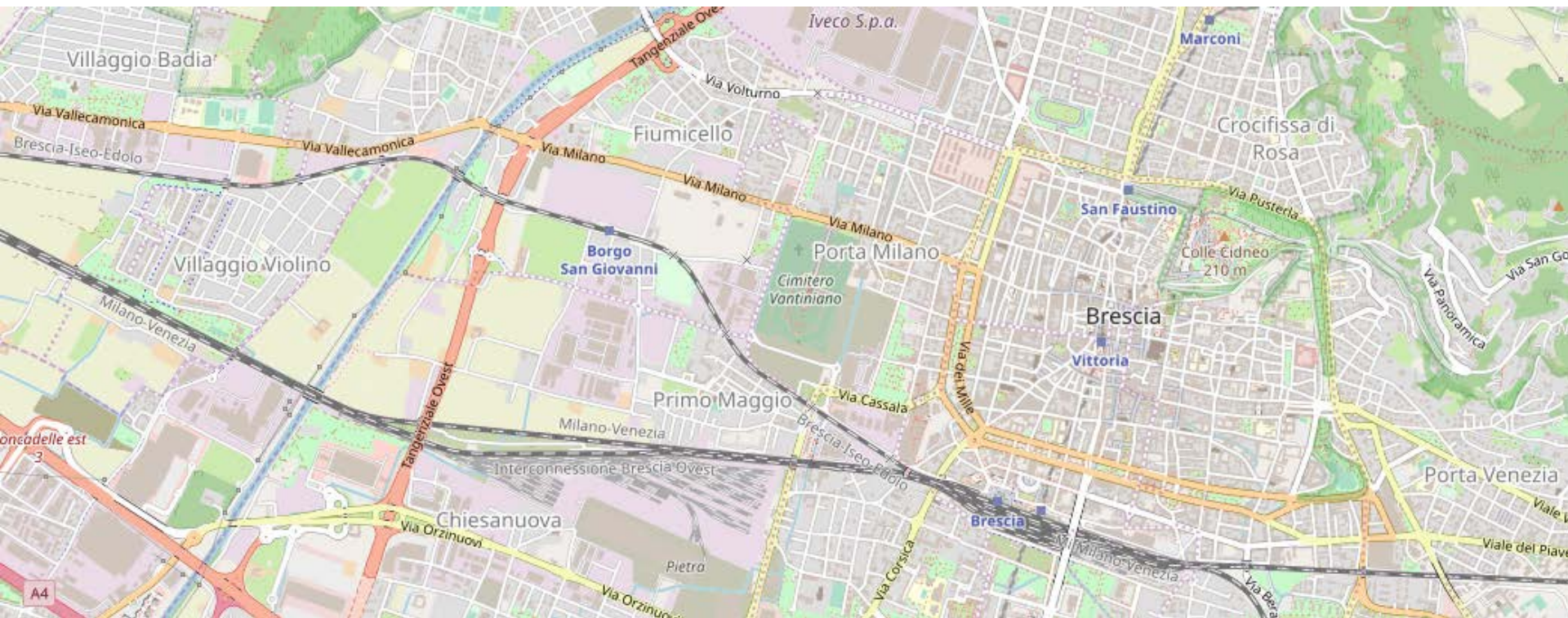*Analisi dell'accessibilità: fermate della metropolitana*

Analysis of overall accessibility to intermodality points

Analisi dell'accessibilità complessiva ai punti di intermodalità

Walk index

Objective

To measure the liveability of an area in relation to the possibility for residents to reach primary services by foot .

Question

From my residence, what is my pedestrian accessibility to services? Which ones can I reach in 5 minutes walking?

Methodology

The analysis has been carried out on the whole Turin Municipality, primarily using the **open data** available on the city website Geoportale.

Geoportale Comune di Torino

To elaborate data we used GIS – Geographic Information System, to calculate the s**ervice areas on the street network** for each one of the selected variables.
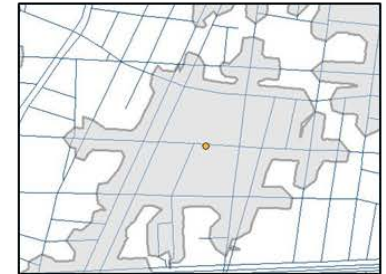
Service area analysis
(400 m / 5 min a piedi)

Each destination has then been weighted according to the frequence of use of the service by citizens.
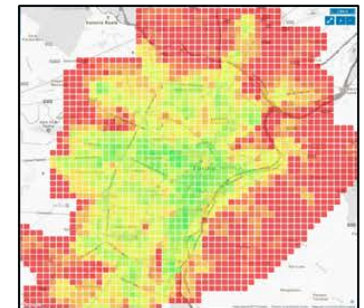
Walk index

The selected destinations

Groceries: convenience stores, supermarkets, food shops, fruit and vegetables, bakeries, butchers, hypermarkets, delicatessens, pastry shops, soft drinks, etc.

Extra food: hairdressers, bars, hardware, newspapers, tobacco, etc.

Mobility: local public transport, underground, etc.

Urban green: gardens and parks.

Loisir: libraries, cinemas, theaters, sports facilities.

Other services: primary schools, municipal and affiliated nurseries, public health care offices, hospitals, pharmacies, general practitioners, post offices, markets, churches.

Service area analysis

The process to define service areas: presence of services that can be reached by walking (400m, around 5 minutes).
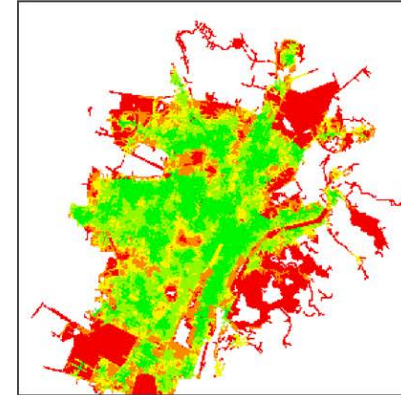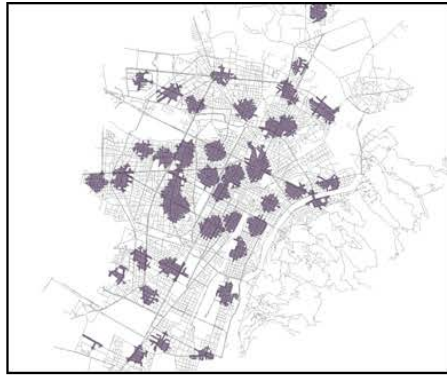

Destinazioni
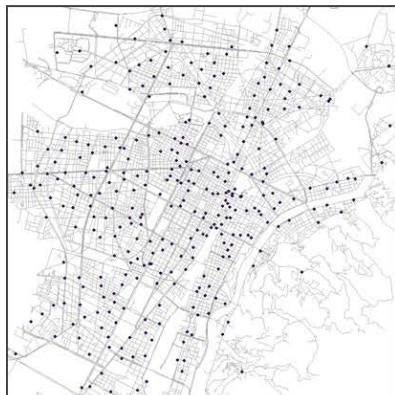
400 metri

Service area
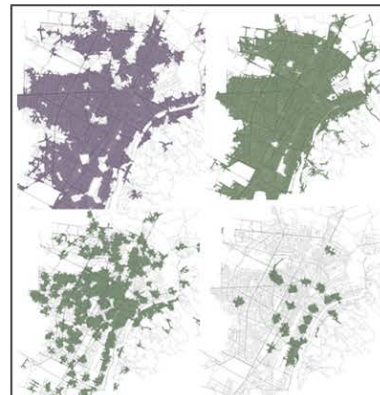
Indice formato raster (50x50)

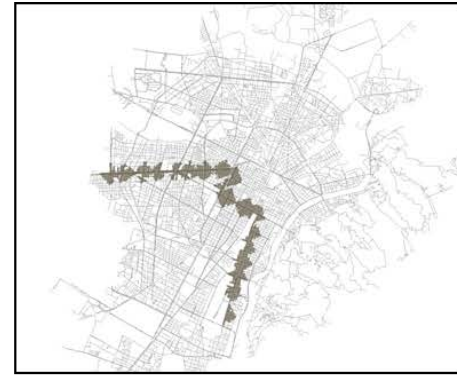# Maps of some of the destinations

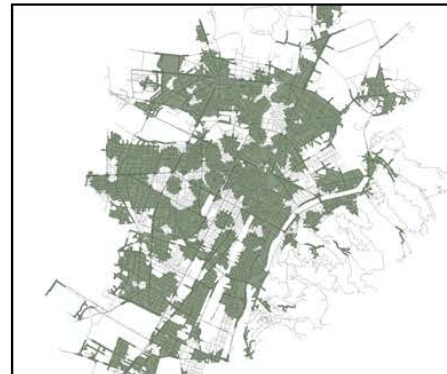Farmacie
Pharmacies

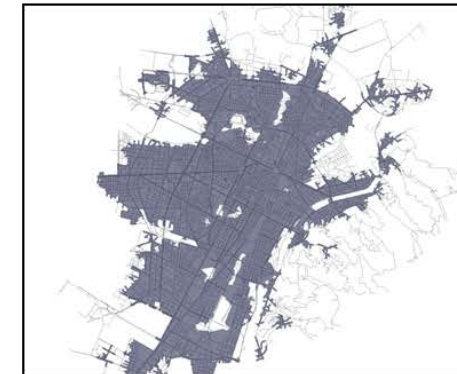Mercati
Markets

Alimentari
Food shops

Metropolitana
Metro

TPL
Public Transport

Sport
Sport

Verde giardini
Gardens and Parks

Acconciatori
Hairdressers

LINKS
iSMB STI

Walk index

- Visualization on static maps
- Visualization on InViTo
- Visualization and interactive calibration of the index on InViTo

InViTo

http://www.urbantoolbox.it/project/walkability/

Destinazione	peso	Destinazione	peso
Alimentari	5	Nidi comunali	3
Aree pedonali	4	Scuole	4
Biblioteche	2	Sedi asl	2
Bike sharing	4	Strutture ospedaliere	3
Caaf	1	Strutture universitarie	1
Cinema	2	Teatri	1
Consultori	2	Uffici postali	4
Extra alimentari	3	Verde giardini	5
Fermate metropolitana	5	Verde parchi	3
Fermate tpl	5	Zone trenta	3
Impianti sportivi	3		

Walk index - visualization

Visualizzazione su griglia

Visualizzazione su rete stradale
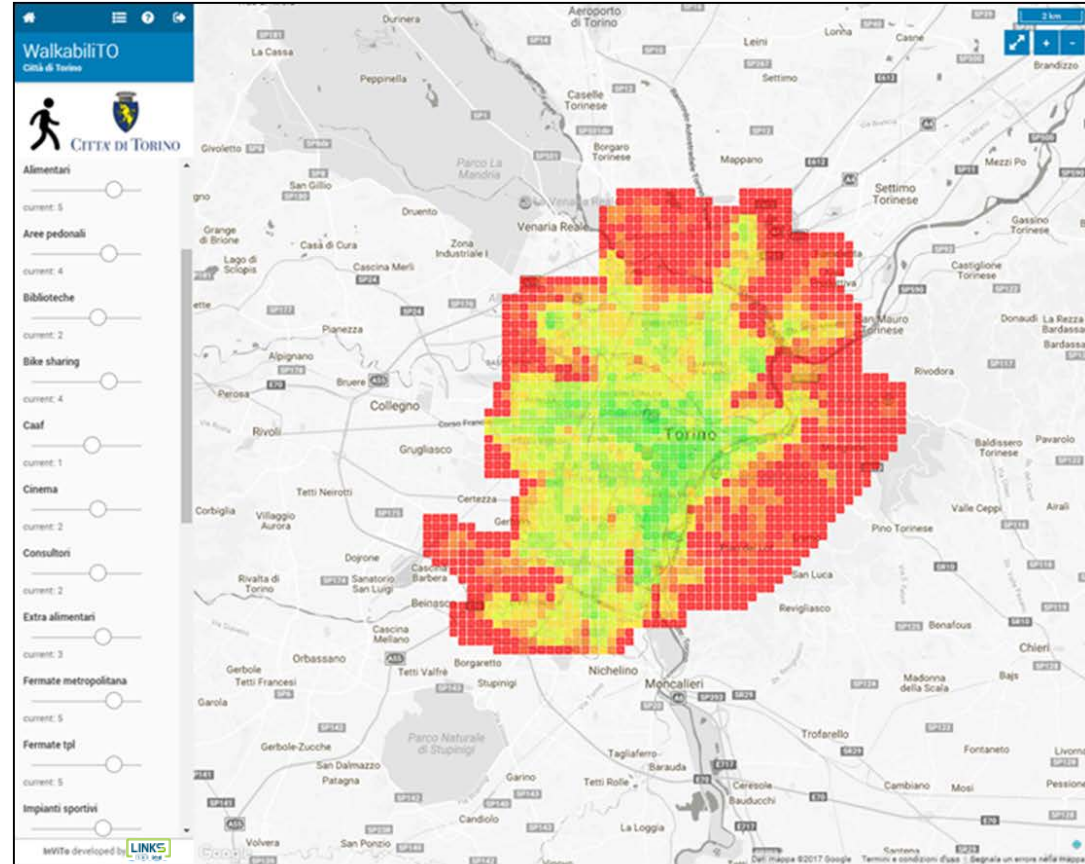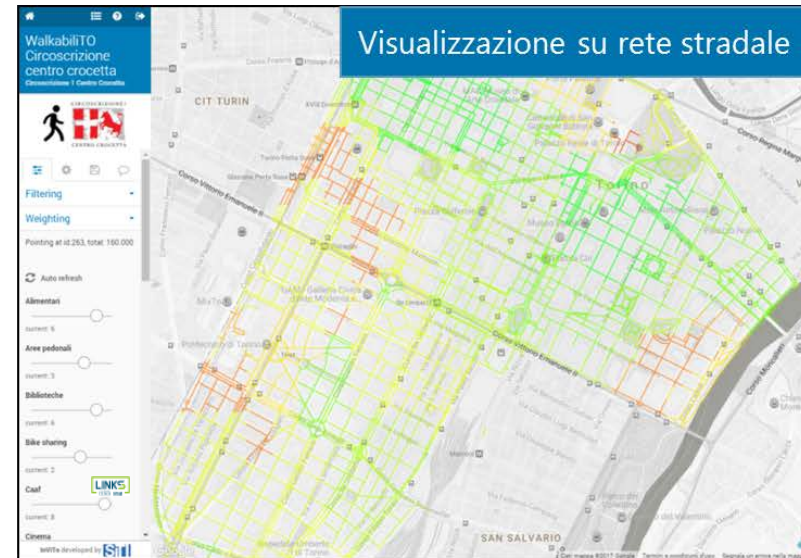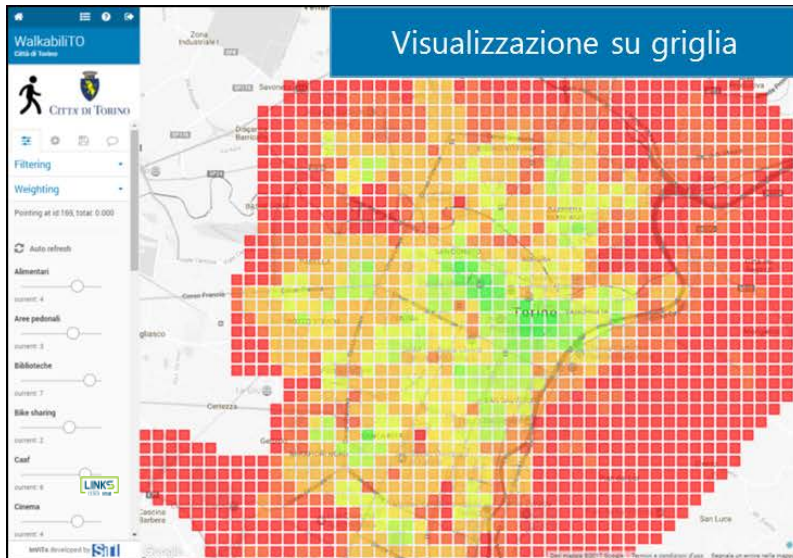
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1630	0	-50	1200	90000	true	0	{"Strutture ospedaliere":0,'
1629	0	-50	1200	90000	true	0	{"Strutture ospedaliere":0,'
1731	0	-50	1200	90000	true	0	{"Strutture ospedaliere":0,'
1759	0	-50	1200	90000	true	50	{"Strutture ospedaliere":0,'
1760	0	-50	1200	90000	true	0	{"Strutture ospedaliere":0,'
1818	0	-50	1200	90000	true	0	{"Strutture ospedaliere":0,'
1789	0	-50	1200	90000	true	0	{"Strutture ospedaliere":0,'

www.urbantoolbox.it/project/walkability
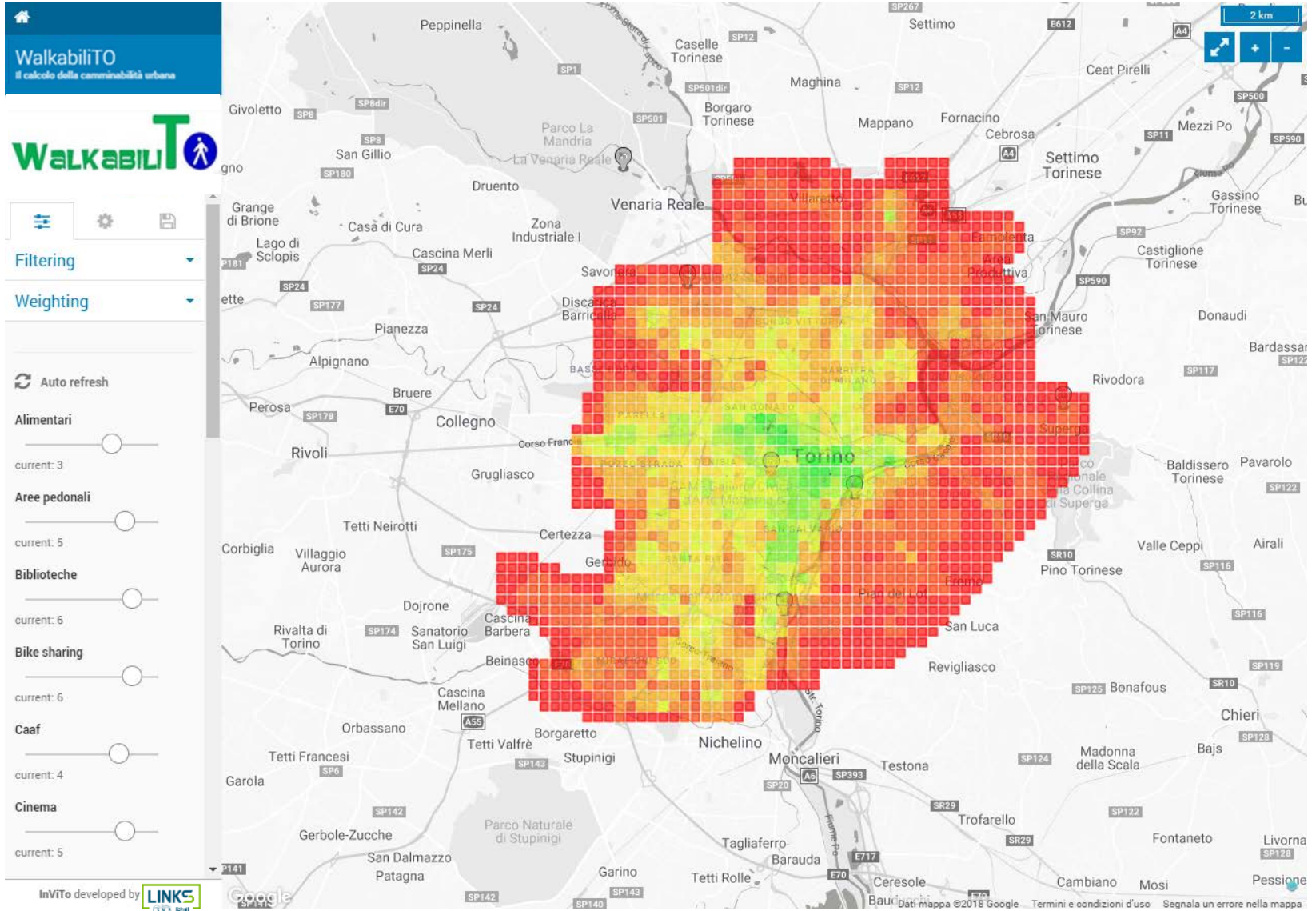
WalkabiliTO
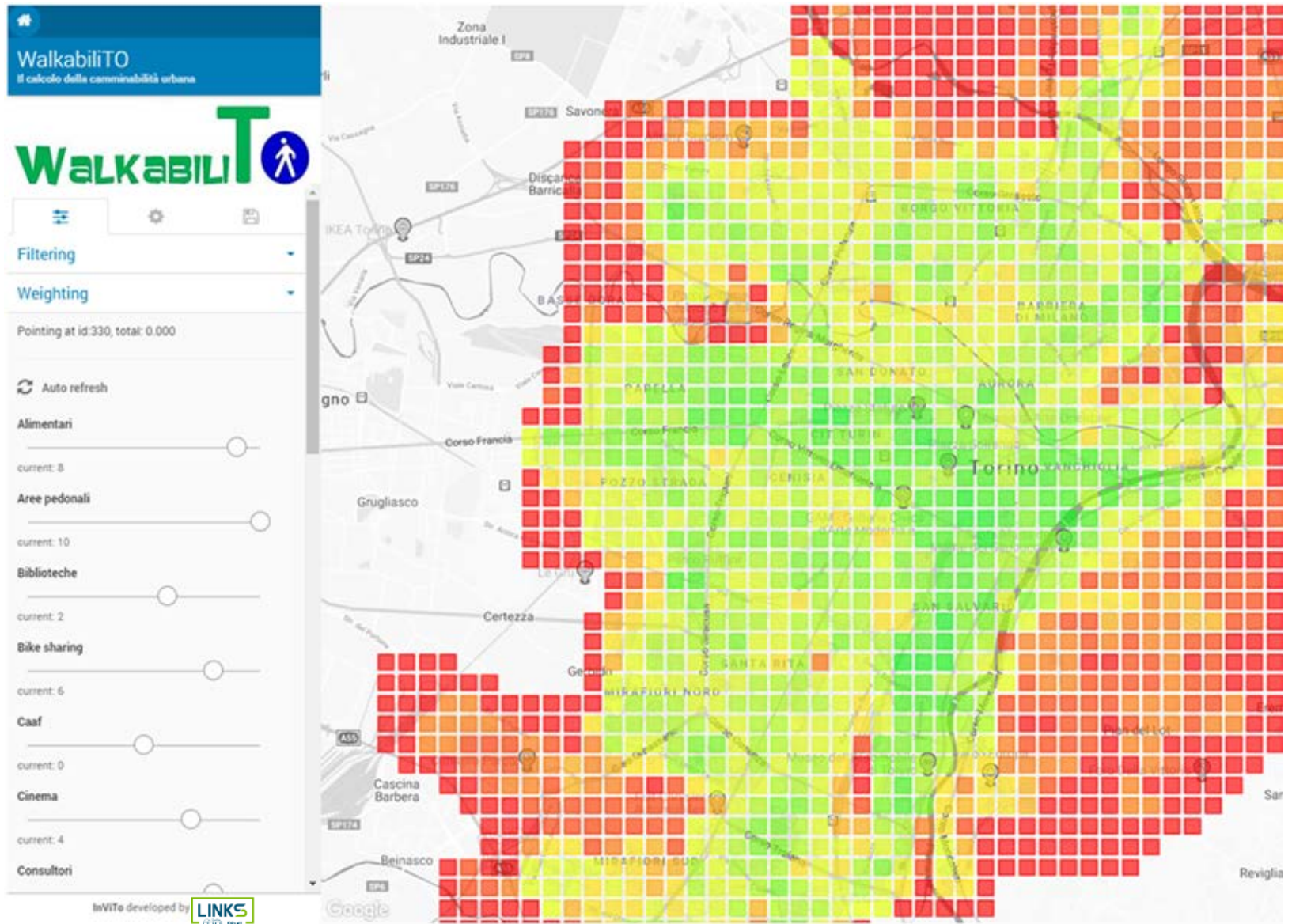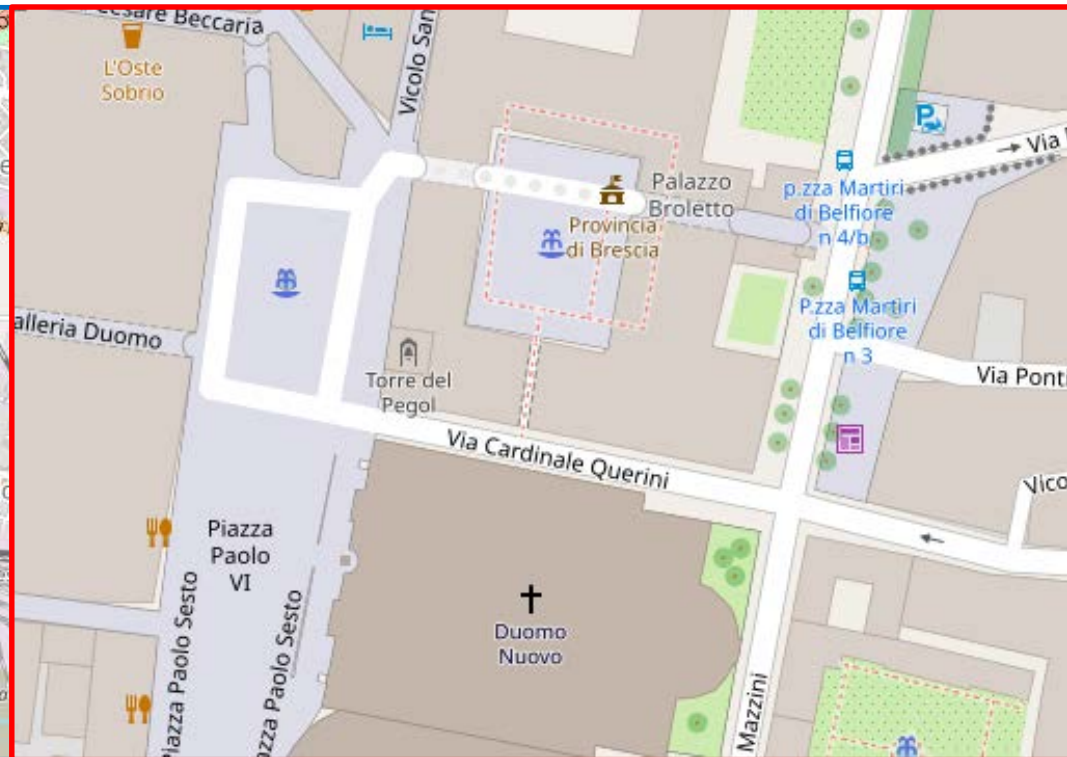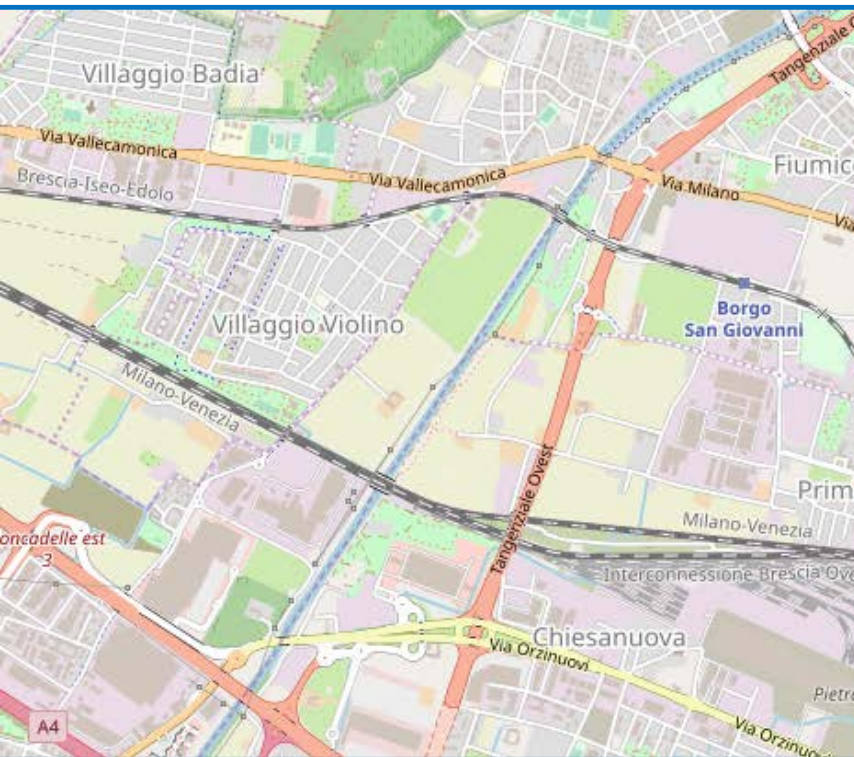
Conclusions

Critical Issues

- **Indices construction and their weight**
- retrieval and re-use of (GIS)data, still not easy (despite the "open by default" tag)
  - impossibility to access some datasets through the web
  - insufficient meta-documentation (for data re-use)
  - «wave encodings» (classification inconsistencies)
  - missing data
  - unavailability of some datasets (i.e. pedestrian crossings…) or restrictive conditions of use

Perspectives

- **Share the "views" on walkability and discuss it, in a GIS environment, with work groups interested in mobility at the neighborhood level**
- Automate (parts of) procedures to use them "live" in communication and participation contexts
- Perform "sensitivity tests" with respect to the various indices and weights used
- Build a (comprehensive and dynamic) "*scores system*" in order to get a feasibility/safety/ pleasure index starting from a geographic location or a path
- Create an **APP** that makes some "views" accessible and allows feedback from individual users

Conclusioni

Criticità

* Costruzione degli indici ed assegnazione dei pesi
* reperimento ed riuso dei dati, tuttora non facile (nonostante l'open by default)
    • impossibilità ad accedere ad alcuni dataset attraverso il web
    • metadocumentazione insufficiente (per il riutilizzo dei dati)
    • codifiche ondivaghe (inconsistenze di classificazione)
    • dati mancanti
    • indisponibilità di alcuni dataset (ad es. attraversamenti pedonali) o provvisti di condizioni di utilizzo «restrittive»

Prospettive

- Condividere le "viste" sulla walkability e discuterne, in un ambiente GIS, con gruppi di lavoro interessati alla mobilità a livello di quartiere
- Automatizzare parti delle procedure in modo da poterle utilizzare *live* in contesti di comunicazione e partecipazione
- Effettuare test di *sensitività* rispetto ai diversi indici e pesi utilizzati
- Costruire un "sistema di punteggi" (completo e dinamico) per ottenere un indice di fattibilità / sicurezza / piacere a partire da una posizione geografica o da un percorso
- Realizzare una app che renda accessibili alcune "viste" e che permetta feed-back da parte di singoli utilizzatori

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