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COMBINED ASSESSMENT OF ENERGY SYSTEMS AND URBAN PLANNING TO EVALUATE THE LONG-TERM IMPACT OF URBAN DEVELOPMENT

ANMA

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1. CITY GROWTH ISSUE

Long-term demographic evolution
Need for housing, jobs, infrastructure, public facilities, etc.

The 50 Largest Cities, C40 Cities, and Top 10 GHG Emitting Cities				
Rank	City	Population (Millions)	GHG Emissions (M tCO ₂ e)	GDP (billion \$ PPP)
1	China	1,392	1,707	14,204
2	India	916	4,058	9,864
3	USA	301	2,606	8,781
4	China	393	2,364	7,903
5	USA	190	2,193	4,354
6	Japan	137	1,374	4,313
7	Brazil	159	1,367	3,388
8	Russian Federation	142	1,214	2,925
9	Germany	82	956	2,288
10	Japan	128	747	2,176

Percentage of population in urban and rural areas France (1950-2050)

How cities can act:

- Concentrating population, emissions, consumption;
- Transforming natural land; Organizing human activity;
- Producing final demand (transportation, heating, food, etc.);
- Gathering flows;
- Being flexible;
- Cooperating internationally; (e.g. BreatheLife Campaign, C40Cities, 100 Resilient Cities)

2. OUR OBJECTIVES

Use data science, GIS, optimal and prospective modelling to tackle long-term impact of urban planning on the environment.

Energy consumption, Mobility, Land-use

3. URBAN PLANNERS' KNOWLEDGE

ANMA's approach:

Ultra-contextual, Low-tech, Existing buildings, Environmentally sensitive, Territorial trends

What matters for urban planners when considering urban evolution?

Choice of relevant parameters

- From the literature;
- From what urban planners use and look at.

Realism of modeling outputs

- Choice of a specific city (Bordeaux in south-west France);
- Link between data collection, processing and the studied territory's reality.

Creation of scenarios

- Retrofitting policy
- Nature and artificial areas equilibrium
- Growth levels
- Transportation policies
- Heat networks

4. URBAN ARCHETYPES

Data → Analysis (PCA, k-means) → "Archetypes"

from open data sources and repositories available for research (INSEE, IGN, Copernicus, Bordeaux, etc.)

Figure: Bordeaux areas colored by cluster

Figure: k-means results on PCA axis

To extract characteristics profiles of the existing city, we look, among others, at...

...buildings

...land-use

Figure: Five types of neighborhood in Bordeaux, buildings colored according to height using data from IGN BDTOPO

Figure: Green space area according to IGN BDTOPO data

For example: - Bordeaux's highly dense center - Similar lots of suburbs or smaller towns - Rural areas

5. LAND-USE OPTIMIZATION MODEL AND RESULTS

CONSTRAINED BY

- Specific areas (protected)
- Political limits
- Useable surface
- Acceptability of towers
- Green spaces
- Energy performance
- Access to public transportation

DEMAND DRIVEN

Population rise generates:

- Housing demand
- Job demand
- School demand
- Mobility demand

Possibility to change final demand to correspond to lifestyles, policies or specific scenarios

Figure: INSEE demographic trend (blue) for Gironde department where Bordeaux is located against a doubling evolution trend

Figure: Bordeaux territory by usability

Figure: Land-use results (right in Perspectives block; buildings results)

Figure: Buildings results

MINIMIZES THE IMPACTS

Separated between:

- Built surface
- Dedicated road
- Natural land
- Other uses (can be converted)

Raw land, Land usage, Usable land, Use of land (buildings), Demand

Building type #1, Building type #2, Building type #n, Natural space (various sizes), Highway, Road, Bike paths, Car, Bus, Bike, Housing demand, Mobility demand

Raw ground, "Buildable" land, "Natural" land, "Transport" land

Land-use type #1, Land-use type #2, Land-use type #n

PERSPECTIVES

- Run the model on all cases
- Enhance the archetypes
- Communicate to urban planners (project on a map)
- Compare with other French cities

With additional constraints:

- Activities
- Mobility demand modes
- Public buildings
- Health (cf. World Health Org. recommendations on green spaces)

Incomplete results