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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.

How cities can act:

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

The 50 Largest Cities, C40 Cities, and Top 10 GHG Emitting Cities			
Rank	Population (Millions)	GHG Emissions (M tCO ₂ e)	GDP (billion \$ PPP)
1.	China: 1,392	1. USA: 7,107	1. USA: 14,204
2.	India: 916	2. China: 4,058	2. 50 Largest Cities: 9,864
3.	50 Largest Cities: 500	3. 50 Largest Cities: 2,606	3. C40 Cities: 8,781
4.	C40 Cities: 393	4. C40 Cities: 2,364	4. China: 7,903
5.	USA: 301	5. Russian Federation: 2,193	5. Japan: 4,354
6.	Indonesia: 190	6. Japan: 1,374	6. Top 10 GHG Cities: 4,313
7.	Brazil: 159	7. Top 10 GHG Cities: 1,367	7. India: 3,388
8.	Russian Federation: 142	8. India: 1,214	8. Germany: 2,925
9.	Top 10 GHG Cities: 136	9. Germany: 956	9. Russian Federation: 2,288
10.	Japan: 128	10. Canada: 747	10. United Kingdom: 2,176

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

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: \mathcal{A} block, h height, w width, d depth, n per person, age

...land-use: road %, built land %, natural %, lots, \mathcal{A} block

and... entropy of land use (Copernicus land cover); distance to the closest public transportation station (bus, tramway);

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

Building types, Land-use types

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

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

Inputs

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