Urban Infrastructure Stress Analysis: Mapping Traffic-Population Dynamics in Zurich (2012-2025)

Project Status & Data Modeling

Team: M. Biya, D. Gao, S. Pun, O. Zeroual

Geospatial Analysis Project, HSLU 2025

Presenting Our Case

The 'Why'

- **Hypothetical Client:** City of Zurich Urban Planning Office
- **Problem:** Increasing population density vs. limited road infrastructure
- **Mission:** Identify "Stress Zones" where population growth outpaces traffic capacity

The Raw Data Landscape

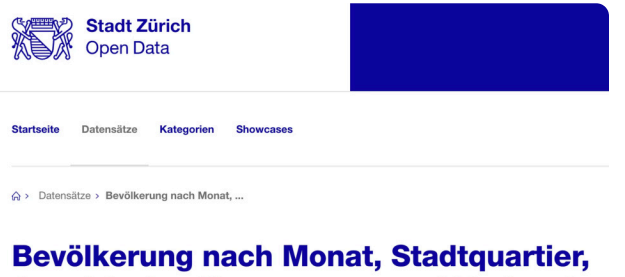
2 + 1 Data Sources

Source A: Traffic Data

Time-stamped car counts on Zurich streets since 2012.

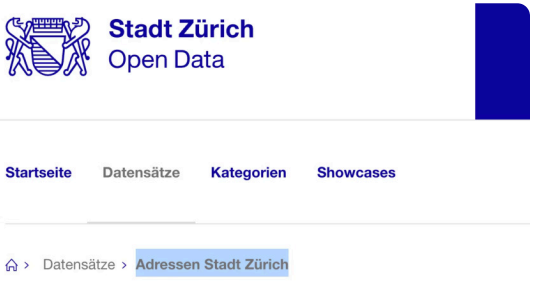
Over 2M rows of hourly sensor readings.

Source B: Population Data



Monthly demographic aggregates for various districts/kreise.

Source X: Geo-Address Data



Connects traffic and population data by street and district.

What is done: The 'Stress Index' Analysis

To quantify the 'stress' on urban districts, we propose the following hypothesis based on linked data:

Data Linkage & Key Metrics

With our data now unified by `DistrictID`, we can analyze key growth indicators:

- **Traffic Volume Growth %** (from Table A)
- **Population Growth %** (from Table B)

The Insight: Identifying District Bottlenecks

The relationship between these growth metrics helps us categorize districts:

- **Commuter Hubs:** Districts where Traffic Growth > Population Growth
- **Residential Zones:** Districts where Population Growth > Traffic Growth

What is achieved: Step-by-Step

01

1. Data Preparation

We loaded, cleaned, and standardized raw traffic, population, and statistical quarter datasets, handling missing values and standardizing formats.

02

2. Geospatial Integration & Aggregation

Traffic sensors were spatially mapped to Zurich's statistical quarters, and yearly traffic and population data were aggregated and merged.

03

3. Growth Rate Calculation

Year-over-year growth rates for both traffic volume and population were computed for each quarter.

04

4. Stress Index Computation

The core 'Stress Index' was calculated as Traffic Growth (%) - Population Growth (%), indicating district dynamics (Commuter Hub, Residential Zone, or Balanced).

05

5. Quarter Classification

Quarters were classified into 'Commuter Hub', 'Residential Zone', or 'Balanced' based on their Stress Index values for simplified interpretation.

06

6. Export for Visualization

The complete dataset, including the Stress Index and its classification, was exported to a CSV file, ready for external visualization.

Our Result Until Now

	A	B	C	D	E	F	G	H	I
1	year	Quar(	quarter	total_populati	quarter_	total_traffi	traffic_growth_pct	population_growth_pct	stress_index
2	2012	11	Rathaus	3141	11	12528744			
3	2013	11	Rathaus	3167	11	12979295	3.5961386073496193	0.8277618592804847	2.7683767480691346
4	2014	11	Rathaus	3188	11	12482229	-3.829684124	0.6630880959898944	-4.49277222
5	2015	11	Rathaus	3214	11	7759976	-37.83180873	0.8155583437892133	-38.64736707
6	2016	11	Rathaus	3189	11	12228606	57.585616244173956	-0.77784692	58.36346316390016
7	2017	11	Rathaus	3215	11	12034869	-1.584293418	0.8153026026967769	-2.399596021
8	2018	11	Rathaus	3245	11	11743323	-2.422510789	0.9331259720062102	-3.355636761
9	2019	11	Rathaus	3269	11	11749113	0.049304613	0.7395993836671888	-0.69029477
10	2020	11	Rathaus	3273	11	11147403	-5.121322776	0.12236157846436946	-5.243684354
11	2021	11	Rathaus	3301	11	11429011	2.526220681175695	0.8554842652001238	1.670736415975571
12	2022	11	Rathaus	3269	11	11394253	-0.304120803	-0.969403211	0.6652824083945075
13	2023	11	Rathaus	3342	11	11038036	-3.126286559	2.2330988069746205	-5.359385366
14	2024	11	Rathaus	3326	11	10545300	-4.463982542	-0.478755236	-3.985227305
15	2025	11	Rathaus	3255	11	8420034	-20.15367984	-2.134696332	-18.01898351
16	2012	12	Hochschulen	675	12	26668585			
17	2013	12	Hochschulen	666	12	25765644	-3.385785185	-1.333333333	-2.052451852
18	2014	12	Hochschulen	662	12	25753836	-0.045828468	-0.600600601	0.5547721322727739
19	2015	12	Hochschulen	626	12	23644789	-8.189253826	-5.438066465	-2.751187361
20	2016	12	Hochschulen	641	12	25329238	7.123975604	2.396166134185296	4.727809469910804
21	2017	12	Hochschulen	642	12	24472776	-3.381317669	0.15600624024960652	-3.53732391
22	2018	12	Hochschulen	666	12	24790670	1.2989699247849984	3.738317757009346	-2.439347832
23	2019	12	Hochschulen	667	12	23891467	-3.62718313	0.15015015015014122	-3.77733328
24	2020	12	Hochschulen	678	12	21074599	-11.79026805	1.6491754122938573	-13.43944346
25	2021	12	Hochschulen	678	12	23401901	11.04316148554001	0	11.04316148554001
26	2022	12	Hochschulen	693	12	22992001	-1.751567106	2.212389380530966	-3.963956486
27	2023	12	Hochschulen	680	12	23579389	2.554749366964626	-1.875901876	4.430651242866501
28	2024	12	Hochschulen	688	12	19957430	-15.36069913	1.176470588	-16.53716971
29	2025	12	Hochschulen	686	12	20119358	0.8113669946480995	-0.290697674	1.1020646690667046
30	2012	13	Lindenhof	955	13	17546957			
31	2013	13	Lindenhof	962	13	15429718	-12.06613204	0.732984293	-12.79911633
32	2014	13	Lindenhof	928	13	15677691	1.6071129751042745	-3.534303534	5.1414165094078035
33	2015	13	Lindenhof	969	13	12327176	-21.37122743	4.418103448275867	-25.78933088
34	2016	13	Lindenhof	964	13	16278250	32.051736748140854	-0.515995872	32.56773262017388
35	2017	13	Lindenhof	982	13	14790021	-9.14243853	1.8672199170124415	-11.00965845
36	2018	13	Lindenhof	957	13	11844024	-19.91881553	-2.545824847	-17.37299068

Challenges & Future Steps

- **Data Cleaning/Processing:**

  Some District missing, due to missing site & district join connection, require manual data cleaning and standardization efforts.

- **Geo Visuals:**

  Mapping the insights from data needs our creativity, translate data into Geospatial Visuals insights that are easy to understand and convincing

- **Next Step:**

  Develop Dashboard and Report

which problematic ones	reason	solution?
Alt-Wiedikon	no site for merge	add coordinates manually
Gewerbeschule	no site for merge	add coordinates manually
Oberstrass	no site for merge	add coordinates manually
Hirslanden	no site for merge	add coordinates manually
Albisrieden	Albisreden exists, spelling difference	manual
Oerlikon	Oerlikon exists, spelling difference	manual
Unbekannt (Stadt Z√ºrich)		to discard