Big-data empowered traffic signal control could reduce urban carbon emission

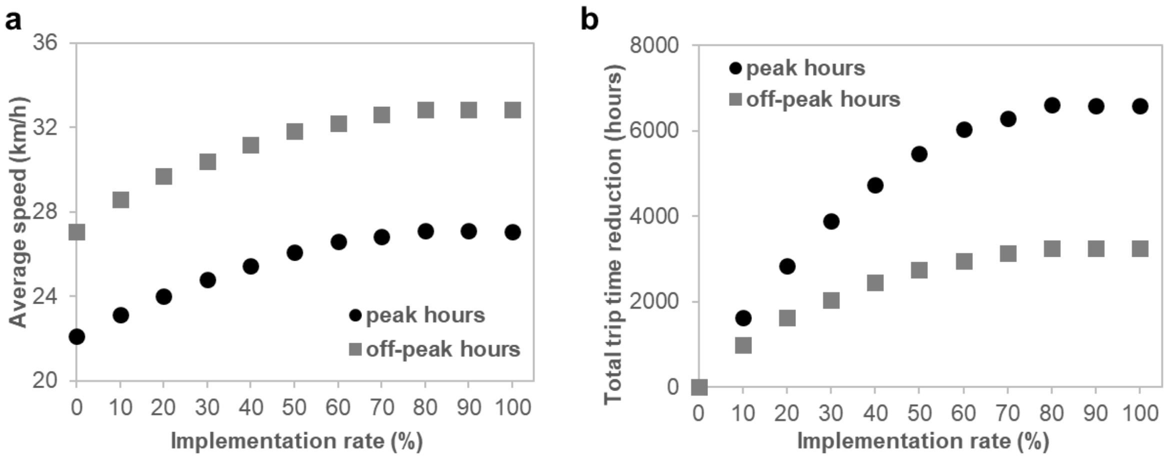
This PDF file includes supplementary tables and figures.

Supplementary Table 1 | Average emission rates by driving mode for passenger cars (gasoline) in the MOVES model.

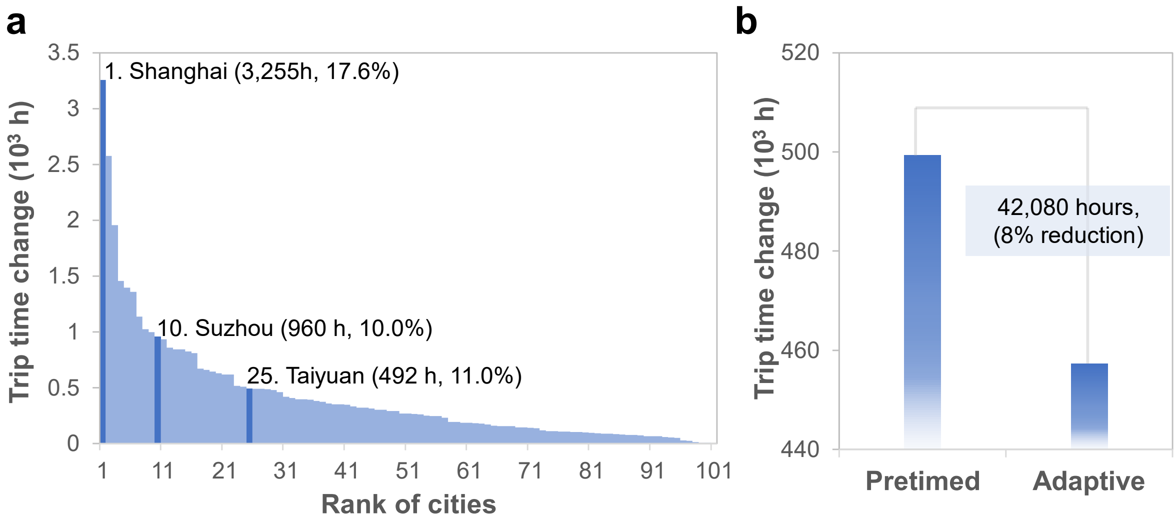
Dring mode	Driving mode definition		CO_2 emission (g/min)
0	Braking		58.8
1	Idling		54.4
2	VSP < 0	1.6 ≤ Speed < 40	85.6
3	0 ≤ VSP < 3		118.2
4	3 ≤ VSP < 6		164.2
5	6 ≤ VSP < 9		207.5
6	9 ≤ VSP <12		247.4
7	12 ≤ VSP		298.8
8	VSP < 0	40 ≤ Speed < 80	116.4
9	0 ≤ VSP < 3		132.5
10	3 ≤ VSP < 6		161.4
11	6 ≤ VSP < 9		207.1
12	9 ≤ VSP < 12		276.3
13	12 ≤ VSP < 18		364.3
14	18 ≤ VSP < 24		491.0
15	24 ≤ VSP < 30		672.7
16	30 ≤ VSP		844.7
17	VSP < 6	80 ≤ Speed	165.9
18	6 ≤ VSP < 12		265.9
19	12 ≤ VSP < 18		346.4
20	18 ≤ VSP < 24		451.7
21	24 ≤ VSP < 30		601.7
22	30 ≤VSP		767.0

Supplementary Table 2 | Comparison among traffic detection techniques.

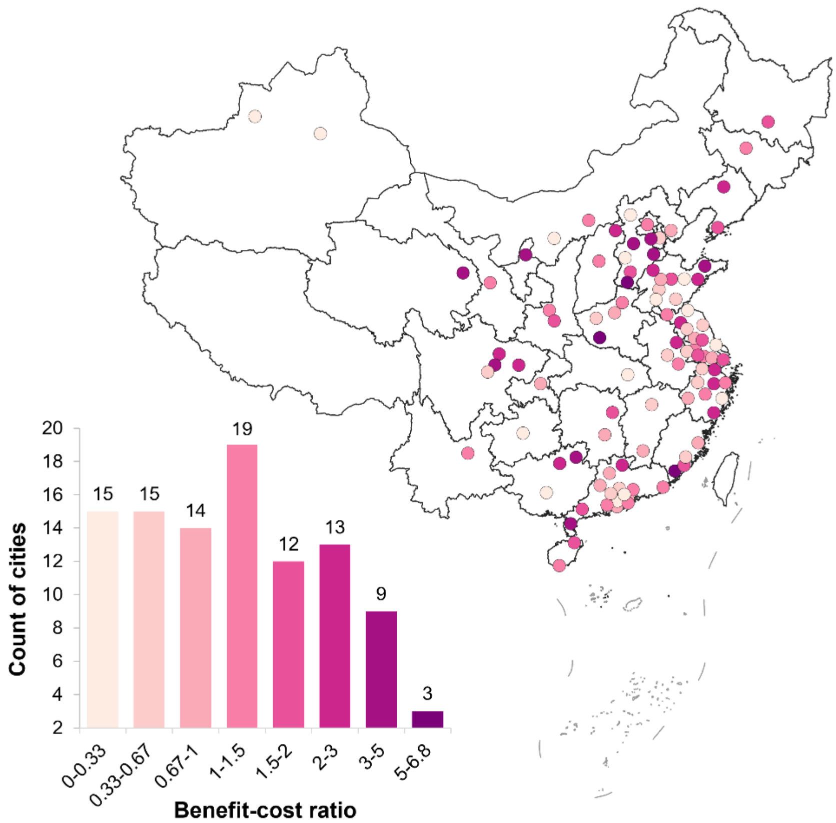
Technology	Ownership	Advantages	Disadvantages
Inductive-loop detectors	Traffic Police Department. Highway agency.	Most consistently accurate detector in terms of traffic volume. Low sensitivity to weather, traffic and environment variation. Technologically mature and highly accepted among transport agencies.	High installation and maintenance cost. Requires civil engineering. Inability to directly measure speed and other information.
Surveillance cameras	Traffic Police Department. Public Security Bureau.	Relatively low installation cost. Advanced object recognition can classify vehicles into categories. Detects pedestrian, bicycles in addition to cars. Capacity of sending over real-time images to a monitor and control room.	Relatively low accuracy and reliability in terms of traffic volume. Performance degradation with bad weather and during night time.
Floating car detectors	Traffic Police Department. Highway agency. Taxi company. Ride-hailing company. Navigation map company. Bus company.	Low implementation cost since these detectors are often installed for other purposes. Detailed vehicle trajectory information may contribute to coordination of traffic control. Ability to directly measure trip origin-density and speed of road segments travelled.	Inability to directly measure traffic volume under low penetration rate. Relying on cross-sector cooperation, the transaction costs may be high. Privacy concerns.



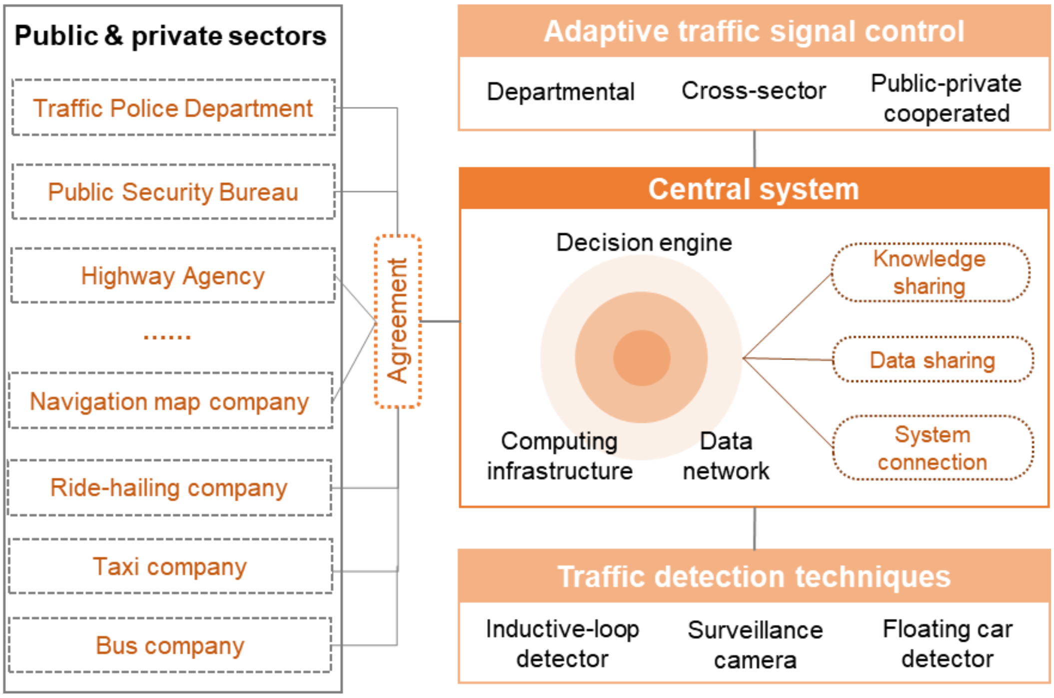
Supplementary Fig. 1 | Impacts of implementation rate of adaptive traffic control in Shanghai. a, Average travel speed over all trips. **b**, Per-hour reduction of travel time over all trips.



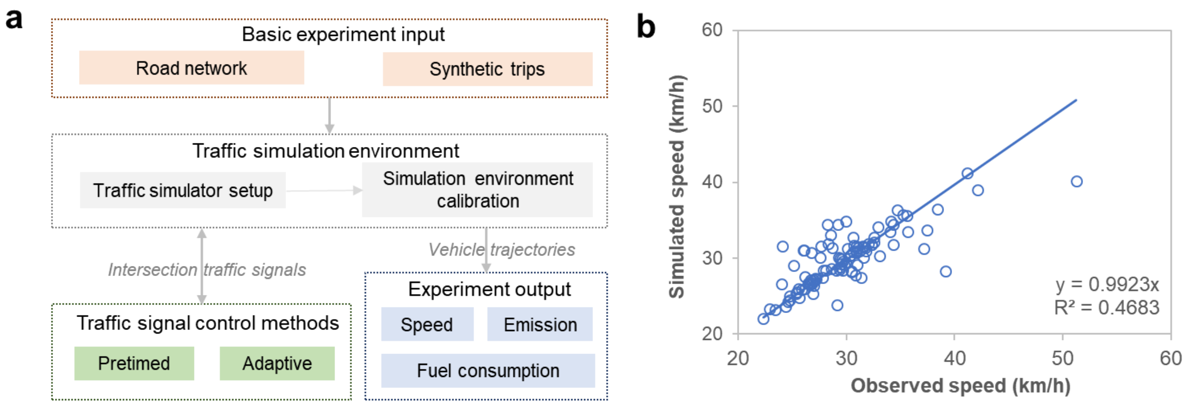
Supplementary Fig. 2 | Changes of trip time during off-peak hours. a, Histogram of per-hour trip time change, above the histogram, typical cities along with absolute and percent trip time changes are labeled. **b**, Total reduction of per-hour trip time change over the 100 cities.



Supplementary Fig. 3 | Benefit-cost ratios across 100 cities based on travel time savings as the sole societal benefit. The base map is applied without endorsement from GADM data (https://gadm.org/).



Supplementary Fig. 4 | Central system for cost-effective traffic data integration and processing. A central system connects isolated systems and facilitates traffic data sharing among public and private sectors. It generally consists of three core elements: a data network, computing infrastructure, and a decision engine. The data network maintains data from multiple sources, including raw data collected by and derived data fused from different traffic detection techniques. The computing infrastructure provides computing resources for data processing. The decision engine supports decision-making for departmental, cross-sector, and public-private cooperated traffic control measures.



Supplementary Fig. 5 | Experiment setup. a, Experiment input, output and key modules. **b**, Correlation between observed and simulated city-scale average speed during peak hours, after calibration of simulation environment.