An Empirical Analysis of Macroscopic Fundamental Diagrams for Sendai Road Networks

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What is the Macroscopic Fundamental Diagram?

Macroscopic Fundamental Diagram (MFD) describes the relation between the number of vehicles in the network and the output flow of the network. The MFD has a potential to be a good performance index of traffic management and control policies for reducing traffic congestion and improving accessibility.

We investigated the issue “what kind of conditions are needed to observed the well-defined MFD in the real world?” by using long term data (one year).

Observation Data

- Long-term data (365 days) observed by fixed detectors in Sendai road network was used
- Traffic flow and speed values were recoded in 288 periods/day with 5-minute period/each
- 1,756 detectors were used in 878 road links
- 4 areas with different sizes are considered

MFD features under standard conditions

- A hysteresis loop always exits under standard conditions (weekday & sunny)
- The shape of the MFD is invariant throughout the entire year

Hysteresis loop formation process

Average flow decrease rapidly with the congestion spread. In the MFD: (the decreasing slope) $S_{1}^f S_{2}^d$ > $S_{1}^i S_{2}^d$ (the increasing slope)

The state changes clockwise along the upper curve when increasing and along the lower curve (hysteresis loop) when decreasing

Effects of traffic demand conditions, weather conditions and area setting

The shape of MFD is changed when there are differences in several conditions:
- Demand-side conditions
- Supply-side (weather) conditions
- Area settings (omitted here)

MFD shapes can be classified based on demand conditions:
- Weekday vs. Saturday & Sunday (holiday)
- In weekday:
  - Normal weekday vs. Weekday after holiday
- In Saturday & Sunday (holiday):
  - Saturday vs. Sunday (holiday)

Snow-Sunday

Rain-Sunday

MFD shape is affected by weather condition: Hysteresis loop become larger.