Air Pollution Control During Urbanization in China

中国城市化过程中空气污染的治理

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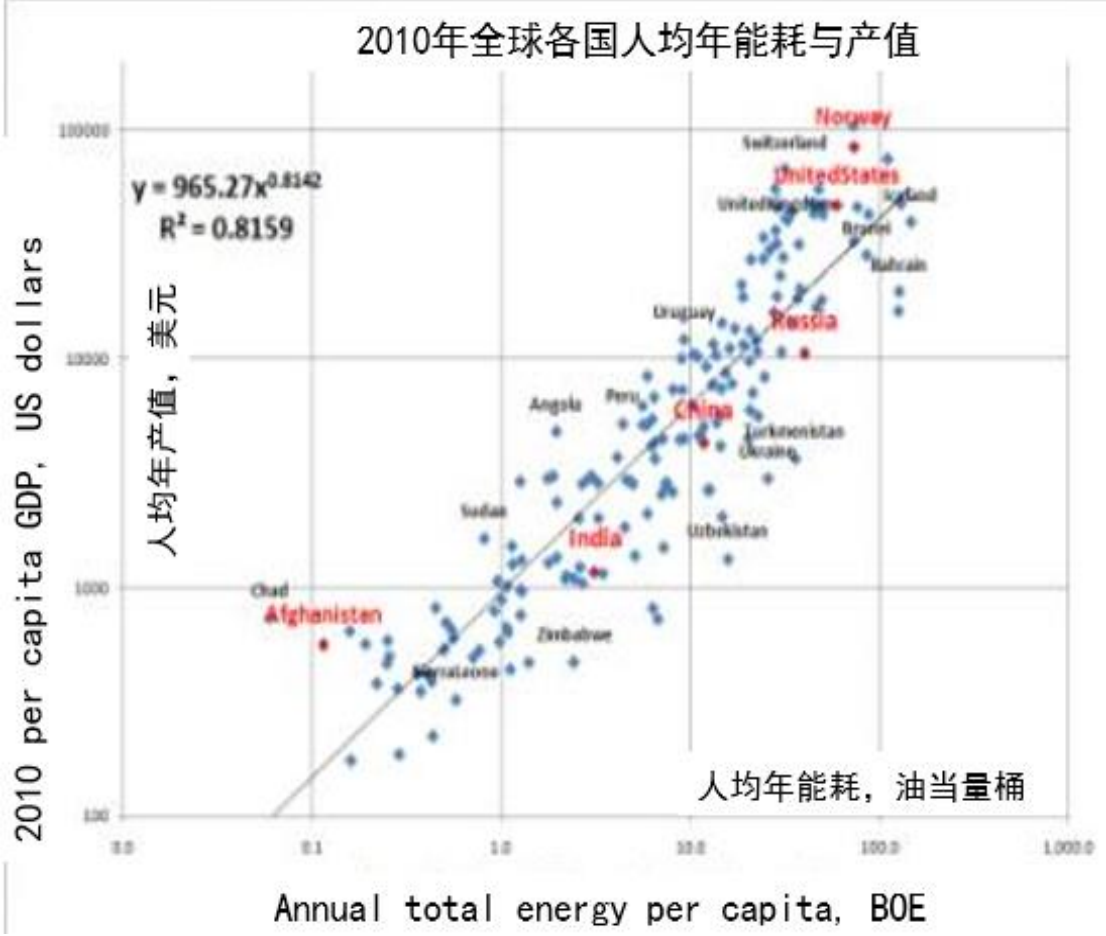
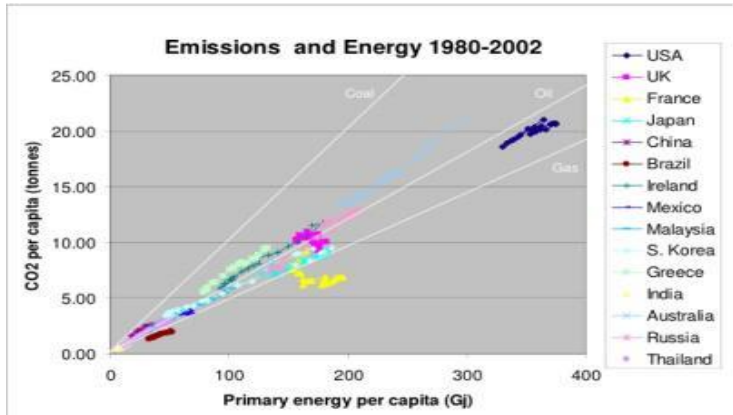
能源和环境是社会发展的基础

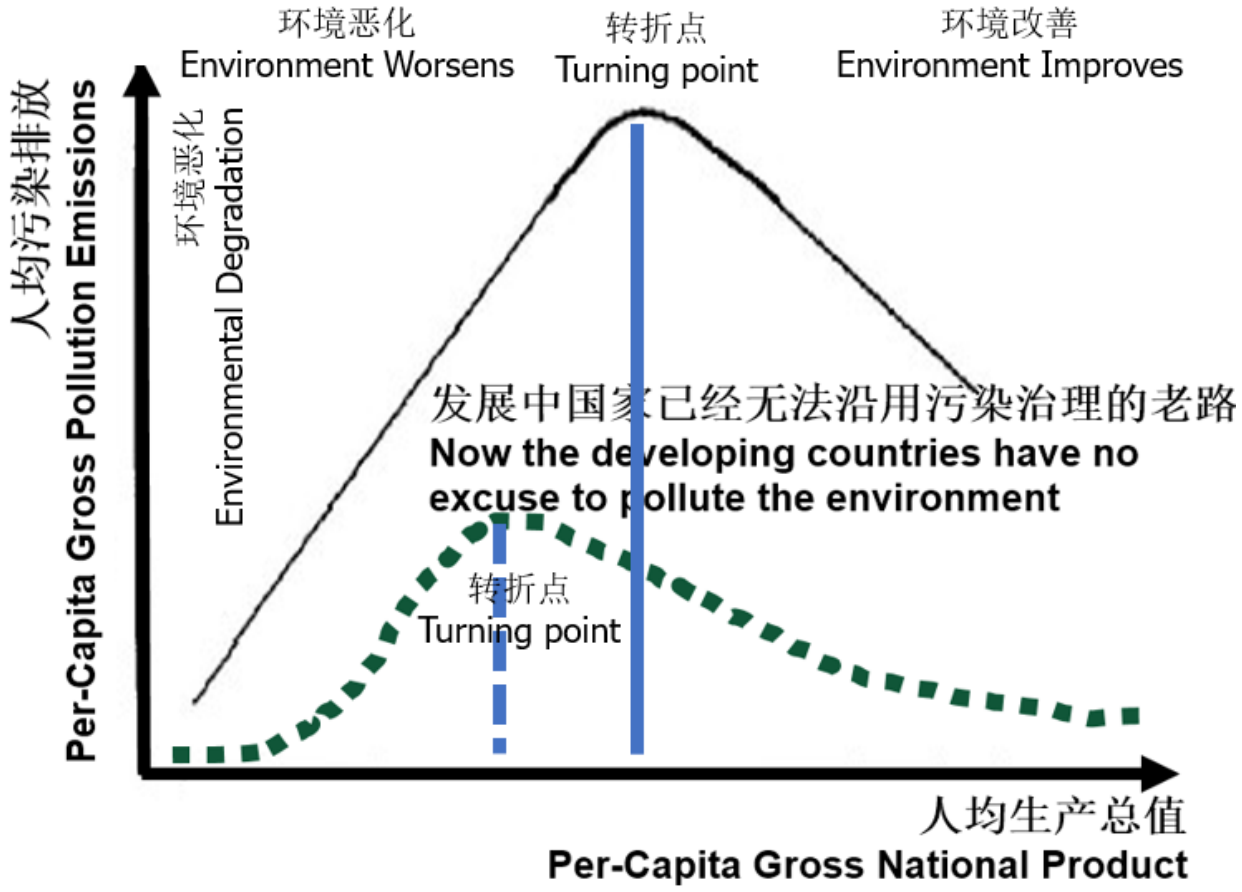
ENERGY AND ECOLOGY: FUNDAMENTALS FOR DEVELOPMENT

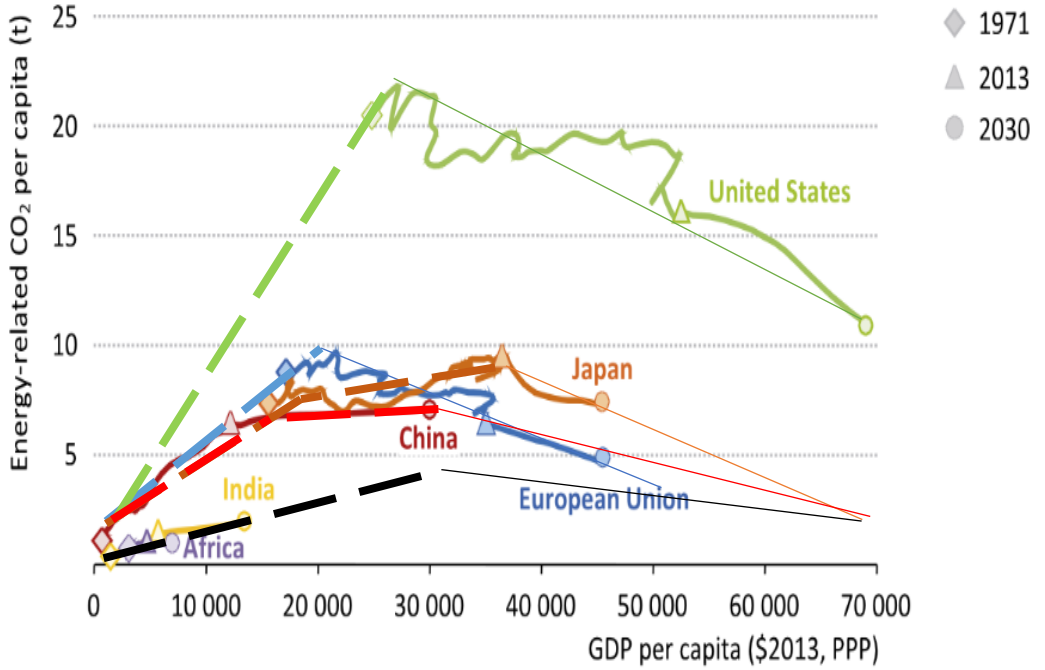




绿色发展是全球社会发展的必经之路

GREEN DEVELOPMENT IS THE ONLY ROUTE FROM NOW





基于人均的生产与污染的倒U曲线（环境库兹涅茨曲线）

Hypothesized Productivity-Pollution Inverted U form on a per-capita base for a given nation as time progresses and development takes place (upper curve see: Arrow, et al. 1996 and Ayers, et al 2001; lower curve: new hypothesis by DONG based on communications) (Environmental Kuznets Curve-EKC)

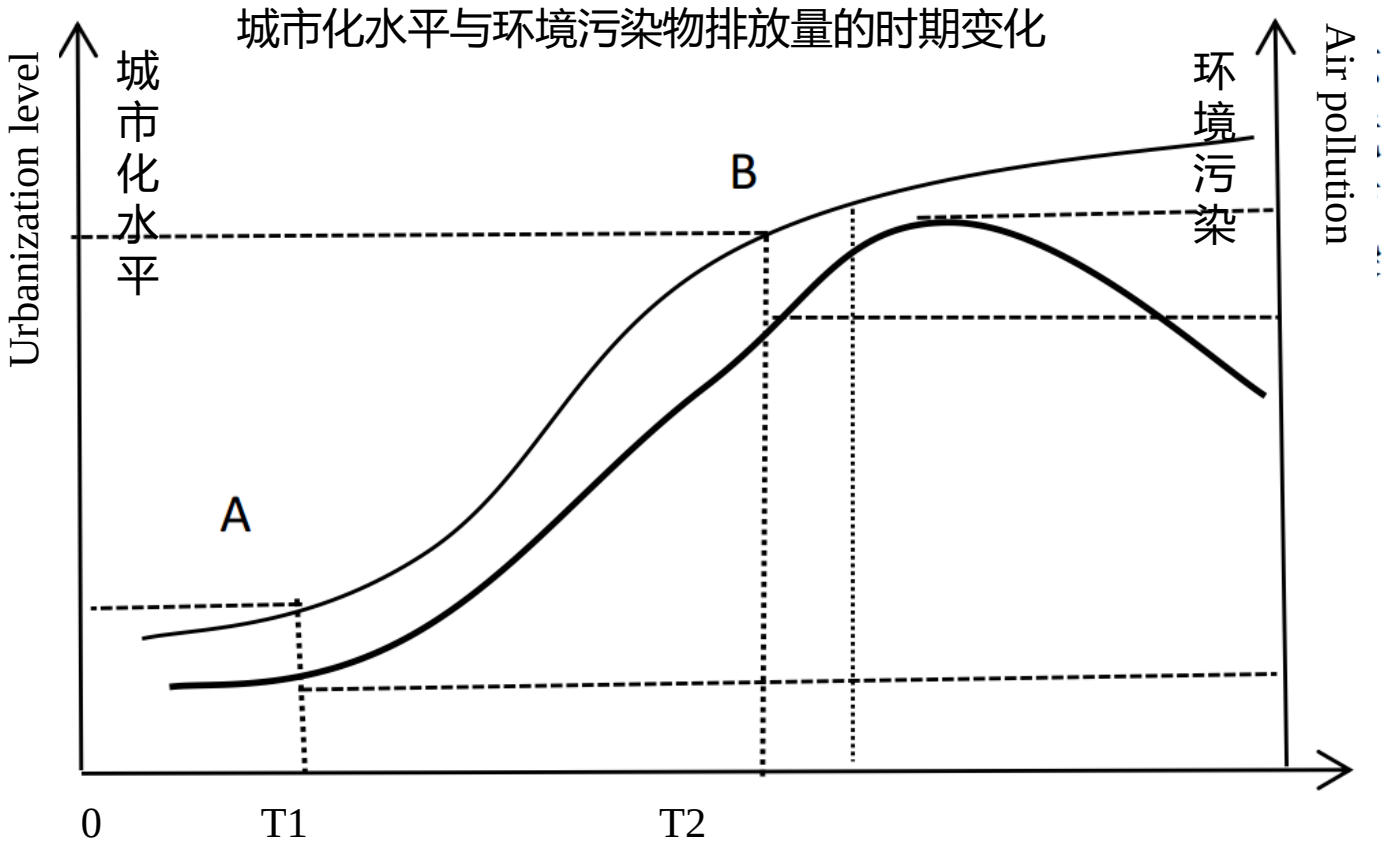
张静蕊.城市化对空气质量的影响研究（M）. 湖南大学.2015.

城市化对空气质量的影响

URBANIZATION ON AIR QUALITY

- 0~T1：城市化初期。农村人口占比大，居民消费少。产业以农为主，工业以资源密集型和轻加工型为主，整体工业生产水平较低；污染排放低，环境恶化缓慢。
- T1~T2：城市化中期、加速阶段。城市化率从 30%提升到 65%，人们对产品和服务的消费大幅上升，生活活动排放污染物相应增加。经济发展属于简单粗放型“资源—产品—排放”模式，高能耗、高污染工业产业迅速发展。城市发展最快，工业污染、生活污染迅速增长。
- T2之后：城市化稳定，城市人口 65%以上。人口增速减缓，倾向于节能环保型产品的消费。经济发展更依靠依靠技术进步，减少资源消耗和污染物排放，走可持续发展的道路。环境污染具有一定粘性，污染物排放会继续增长，直到经济发展带来的技术效应大于人口、 资源在空间上集聚产生的规模效应，环境污染曲线越过拐点。

- 0~T1: early stage of urbanization. The rural population accounts large, the resident consumption is low. The industry is mainly agriculture-related, and is resource-intensive and light industry. Low productivity, low pollution and slow environmental deterioration.
- T1~T2: the middle and accelerating stage of urbanization. The urbanization rate has been increased from 30% to 65%. Consumption increased significantly. Industrial “resource-product-emission" development results in high energy consumption and high pollution.
- After T2: Stable 65% urbanization. Population growth is slowing down, favoring energy-saving and environment-friendly products. Economic development depends more on technology, following the path of sustainable development. Environmental pollution is sticky to a certain extent, and pollutant emissions continues to grow until technology-driven development is greater than resource-dependent development.



Urbanization vs Air pollution over time

早期城市化中影响空气质量的因素

FACTORS ON AIR QUALITY DURING EARLY STAGE URBANIZATION

城市化过程起步阶段重经济发展，轻环境保护，影响空气质量：

- 城市化初期和在中小城市中，工业布局不合理，技术落后，大气污染严重
- 大中城市低效高排放燃油机动车大量增加，使汽车尾气中氮氧化物、一氧化碳等污染物排放量过大
- 小城市发展方向及目标不明确，能源结构不合理，生物质粗放燃烧以及煤炭，导致大量烟尘、硫化物

基于湖北省 16 城市 2005 ~ 2017 年城市化过程的分析：

- 民用汽车的数量、公路里程对城市空气中 SO2、NO2、PM10含量有显著正向影响
- 工业化水平对空气中 SO2、NO2显著负向影响，对 PM10含量有显著正向影响
- 人均绿地面积对空气中 SO2 的含量有显著负向影响，对 NO2、PM10的影响不显著

In early urbanization, economic development was thought to be more important than environmental protection:

- The industrial layout was not reasonably planned, taking economic output as the priority only
- In large and medium-sized cities, a large increase in inefficient and high-emission fuel vehicles, resulting in excessive emissions of nitrogen oxides, carbon monoxide and other pollutants in automobile exhaust
- Small cities development plan was not clear. Biomass and coal combustion led to a large amount of soot and sulfide

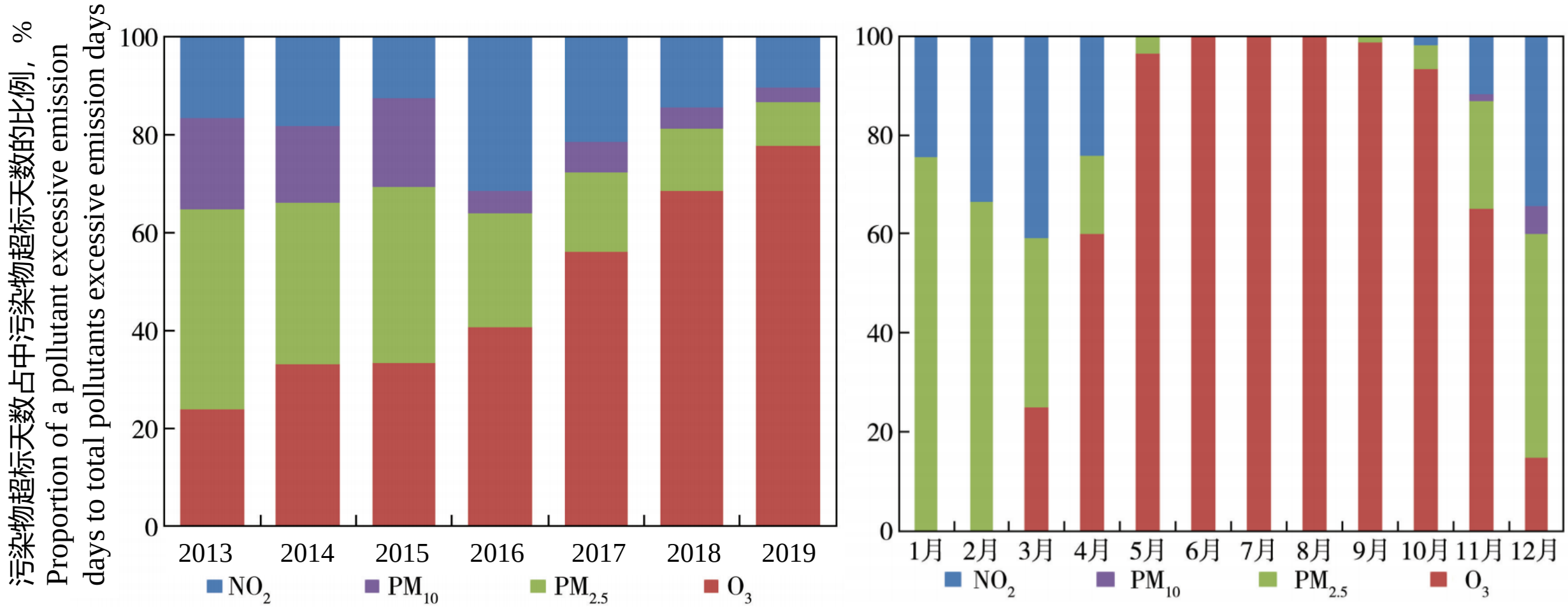
Based on the urbanization process of 16 cities in Hubei Province from 2005 to 2017:

- Civil cars and highway mileage cause significant SO2, NO2 and PM10 increase in the urban air
- Further industrialization contributes significant reduction of SO2 and NO2, and a significant PM10 increase
- Urban afforestation has a significant effect on SO2 reduciton, but has no significant effect on NO2 and PM10

汪发元等，城市化水平、 工业化水平对空气质量的影响分析.长江流域资源与环境. 2019, 28(6):1411-1421
Analysis of the Influence of Urbanization and Industrialization Level on Air Quality. Resources and Environment in the Yangtze Basin

快速城市化中空气质量变化-深圳市宝安区

AIR QUALITY EVOLUTION IN RAPID URBANIZATION: BAOAN OF SHENZHEN



张燚等.快速城市化典型城区空气质量动态变化和机理研究. 环境生态学. 2021, 3(12): 7-13
Trend and mechanism of air quality change in typical urban area with rapid urbanization. Environmental Ecology.

广州：现代化城市的新型城市化

GUANGZHOU: MODERN CITY'S NEW URBANIZATION

- 30 年的经济和人口的快速增长导致广州市面临资源和环境的严峻挑战。制约广州城市化发展水平的不再是城市规模问题，而是城市质量和功能问题。
- 循环和生态化发展是新型城市化的主要特征。“人口、资源、环境、发展”互相协调，物质、能量、信息高效利用，推行循环经济和低碳经济。
- 广州市新型城市化经历如下四个阶段: ①改革开放至 20 世纪 90 年代， 生态城市思想引入城市化；②2000 ~ 2005 年，开展生态专项规划；③2006 ~ 2010 年，加强对城市生态系统的主动保护和利用;④2010 年以后，国家生态文明建设政策引领，发展“花城、绿城、水城”生态城市。

- Thirty years of rapid economic and population growth has led to severe challenges of resources and environment in Guangzhou. In Guangzhou, the city quality and function, no longer the city size, is the priority of new urbanization. .
- Circular and ecological development are the main characteristics of new urbanization. "Population, resources, environment and development" should coordinate with each other to make efficient utilization of energy, resources and information, so as to promote circular economy and low-carbon economy.
- The new urbanization of Guangzhou has experienced four stages: (1) During 1980s and 1990s, the eco-city concept was introduced into urbanization; (2) 2000 to 2005, special ecological planning was carried out; (3) 2006 to 2010, protection and utilization of urban ecosystem was activated; (4) Since 2010, under the guidance of national ecological civilization policy, Guangzhou ecological city has been on the track of “flower city, green city and water city" construction.

江璐明等.新型城市化背景下的广州市生态城市发展战略. 安徽农业科学. 2016.44(24):219-222
The Ecological City Development Strategy under the Background of New Urbanization in Guangzhou City. Journal of Anhui Agricultural Sciences

改善城市大气质量的措施

ACTIONS FOR IMPROVING CITY AIR QUALITY

- 提高民众环保意识，引导消费。例如控制燃油机动车、增加清洁能源车辆和公共交通等低排放供给
- 重视城市绿化，营造卫生防护林
- 根据气候条件、地理环境、资源禀赋等，合理布局城市工业，淘汰高污染、高能耗产业
- 控制大气污染源，在提高生活质量的同时降低能源消耗
- 加强大气污染物监测，加强水土玩染物监测
- 完善大气污染控制的法律法规

- Public awareness of environmental protection for consumption transition. For example, fuel vehicles shift to clean energy vehicles, and public transport low emission transition, etc.
- Urban afforestation enhancement
- Urban industries to be rationally planned, to remove high pollution and energy consumption industries
- Careful manage air pollution sources, reduce energy consumption while improving the quality of life
- Monitor air pollutants, and water and soil contaminants
- Improve laws and regulations framework for air pollution control

广东省环境空气质量持续改善行动计划（2021-2025 年）

ANAEROBIC FERMENTATION: BIOGAS PLANTS

（一）严控“两高”行业，实施产业绿色转型提升行动
（二）改善能源结构，实施能源清洁化替代行动
（三）调整交通结构，绿色交通系统建设行动
（四）实行全过程管控，实施VOCs深度减排治理行动
（五）适度提质增效，实施锅炉炉窑分级分类治理行动
（六）全面扩展提升，实施移动源系统防控行动
（七）做精做细做实，实施面源精细化管控行动
（八）精准高效防控，实施重点时段臭氧污染攻坚行动
（九）提升科学治气能力，实施蓝天保卫科技支撑行动

1. Industry green transformation.
2. Energy structure improvement with transition to clean energy.
3. Traffic structure changed to a green transportation system.
4. Whole-process control and reduction of VOCs.
5. Appropriately upgrade the quality and efficiency of boilers and furnaces.
6. Comprehensive upgrade the mobile source emission control.
7. Carry out detailed control over non-specific sources.
8. Efficient prevention and control of ozone pollution.

9. Ability enhancement to control air quality: standards and regulations development, information platform upgrading, law enforcement, scientific and technological capacity building.

谢谢大家

Thank You!

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