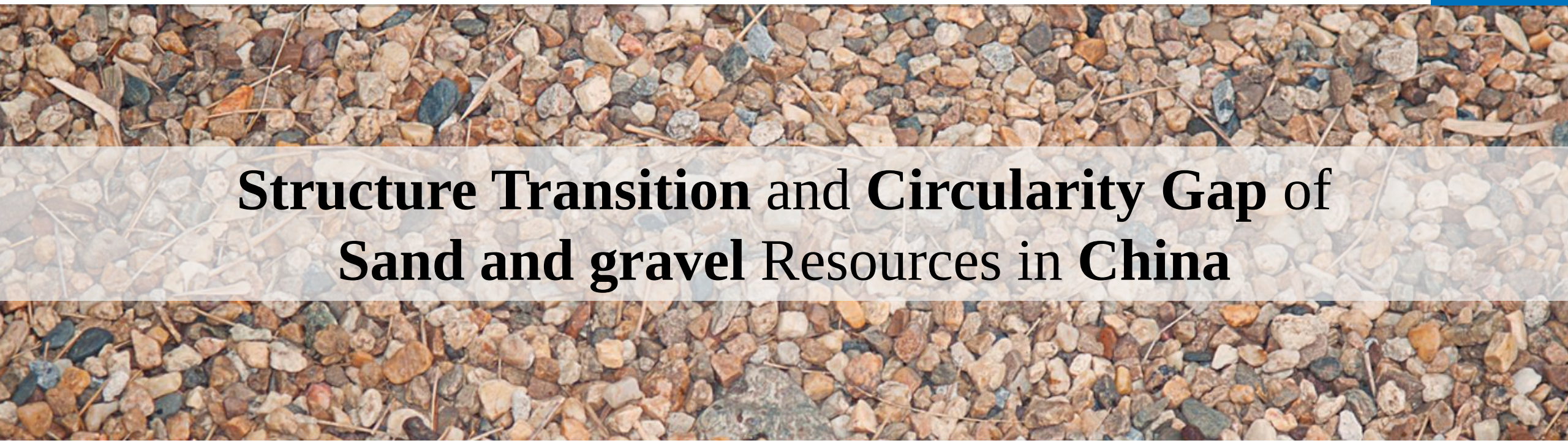

Structure Transition and **Circularity Gap** of **Sand and gravel** Resources in **China**

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Aggregates: Important construction material and facing resource crisis

What is aggregate resource?

Sand, gravel, and crushed stone are collectively referred to as **construction aggregates**

Resource properties

- **Natural aggregates:** River sand, lake sand, mountain sand, desalinated sea sand, pit sand, pebbles
- **Manufactured aggregates:** Raw ore (≥20 CAT), Pebbles, Tailings, Waste rock

Construction Aggregates

Final Uses

Building

Road

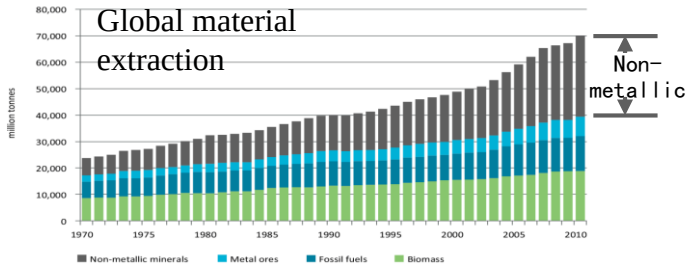
Railway

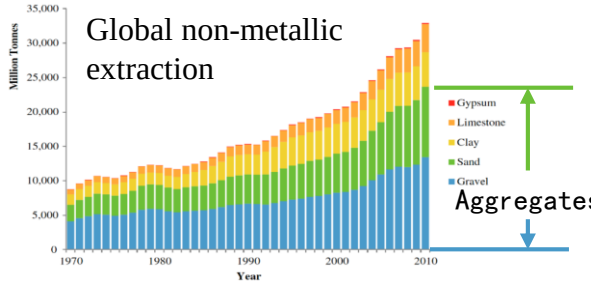
Bridge

.....

Why look into aggregate resource?

- **Important resource:** Widely used in construction field, playing an important irreplaceable role
- **Huge amount:** Aggregates are **the most extracted material resources by weight** worldwide (**40-50 billion tons** in recent years, **half of the total** set material resources)





UNEP, 2016

- **Ignorance and severe impacts:** Aggregate resources **didn't receive enough attention** for a long time since they are considered as **high in volume but low in value**

Illegal sand mining

Severe environmental impacts

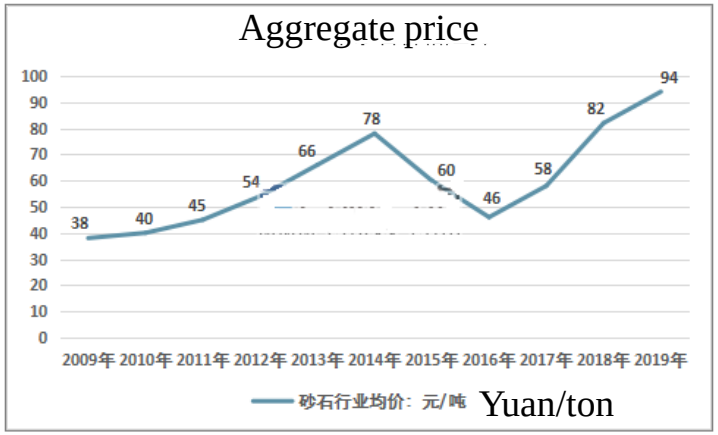
Problem

China: The largest aggregates consumer and producer

- **China accounts for half** of the global aggregate consumption

The Economist, 2017

- **Sand crisis in China**
  - **Demand exceeds supply**
  - **Natural sand exhausted**
  - **Small mines closed** due to environmental supervision



Source: China Aggregates Association

- **Chinese government attached great importance on sand issues**

Ministry of Industry and Information Technology of China, 2019

National Development and Reform Commission of China, 2020

Introduction

Urgent need for aggregate resource measurement in China

- **Huge amount of demands → Demand exceeds supply**
- **Huge amount of extraction → Sand exhausted & Severe environmental impacts**
- **Huge amount of natural stock → Ignorance**

Quantitative information is required for sustainable development of aggregate resource.

However, most developing counties like **China don't have statistic data on aggregate resource.**

UNEP, 2019

UNEP recommends:

Invest in **sand production and consumption measurement**, monitoring and planning

Research question

Establish a material flow analysis (MFA) framework for aggregate resources in China to quantify aggregate resources so as to support relevant policymaking

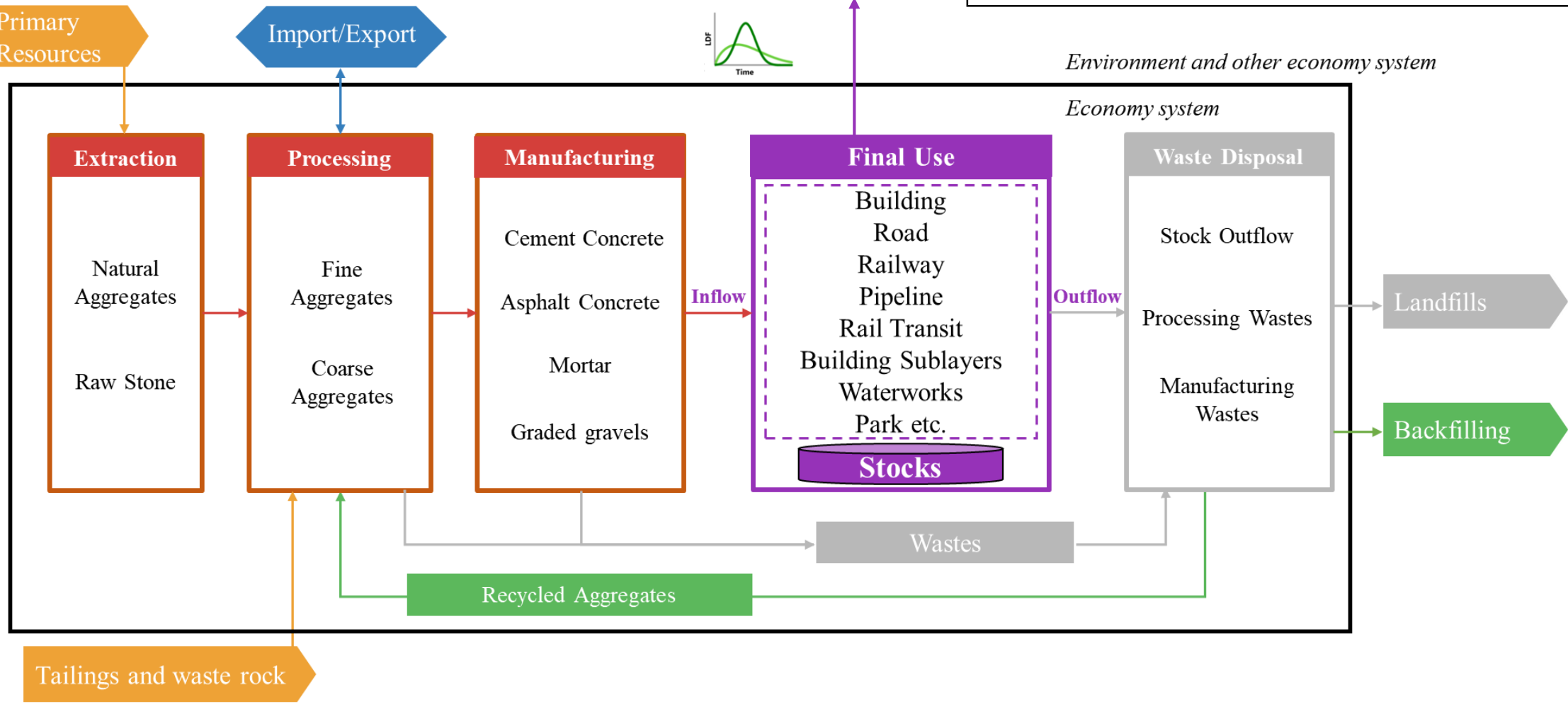
Method Social metabolism model for aggregates base on MFA

- Underlying data
- Material intensity
- Lifetime distribution

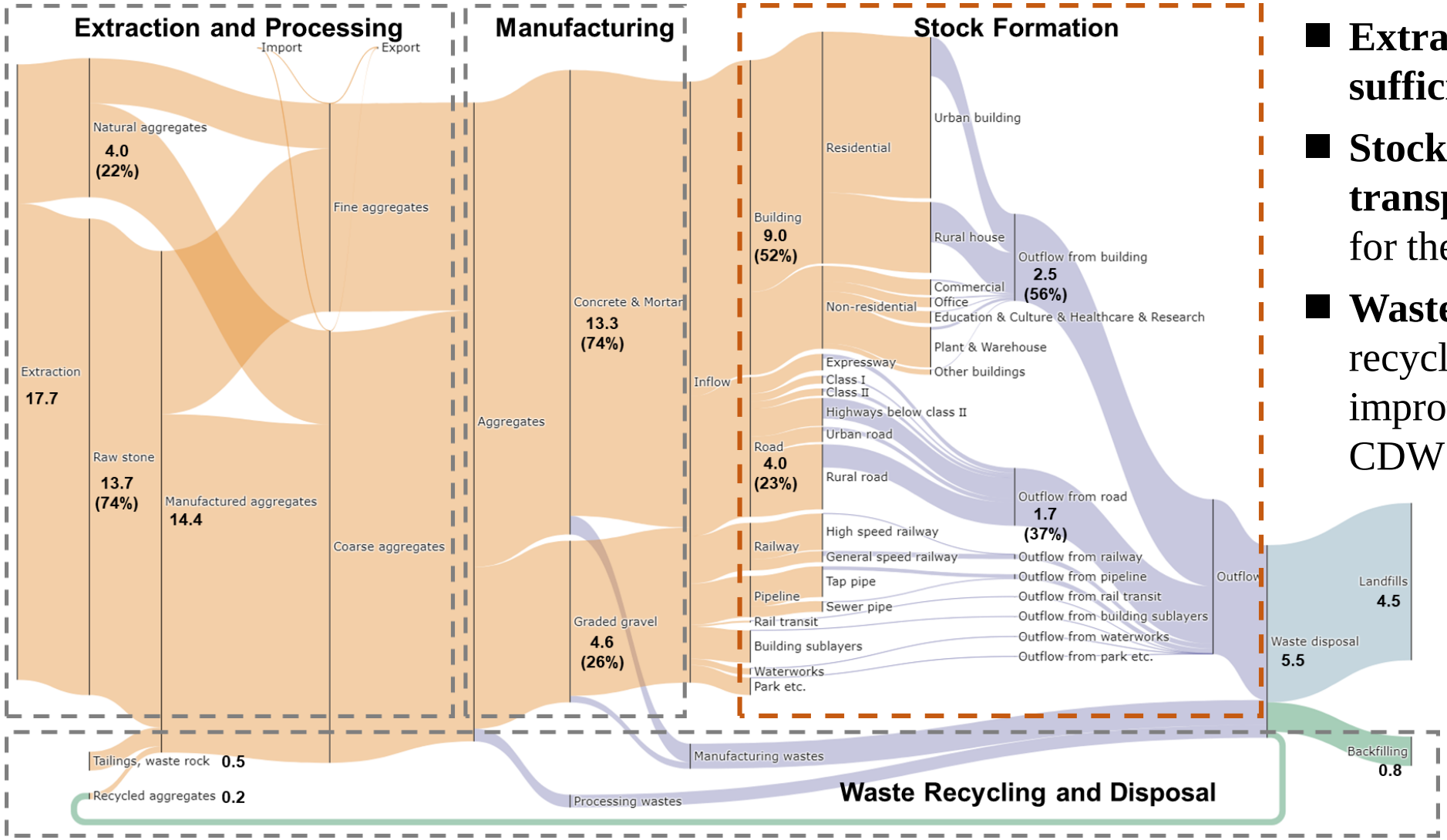
×21 categories of final uses
×long time series(1978-2018)

Core of the model Dynamic-MFA

- Inflow: how many aggregates flow into the social economy
- Stock: how many aggregates exist in the social economy
- Outflow: how many aggregates flow out of the social economy



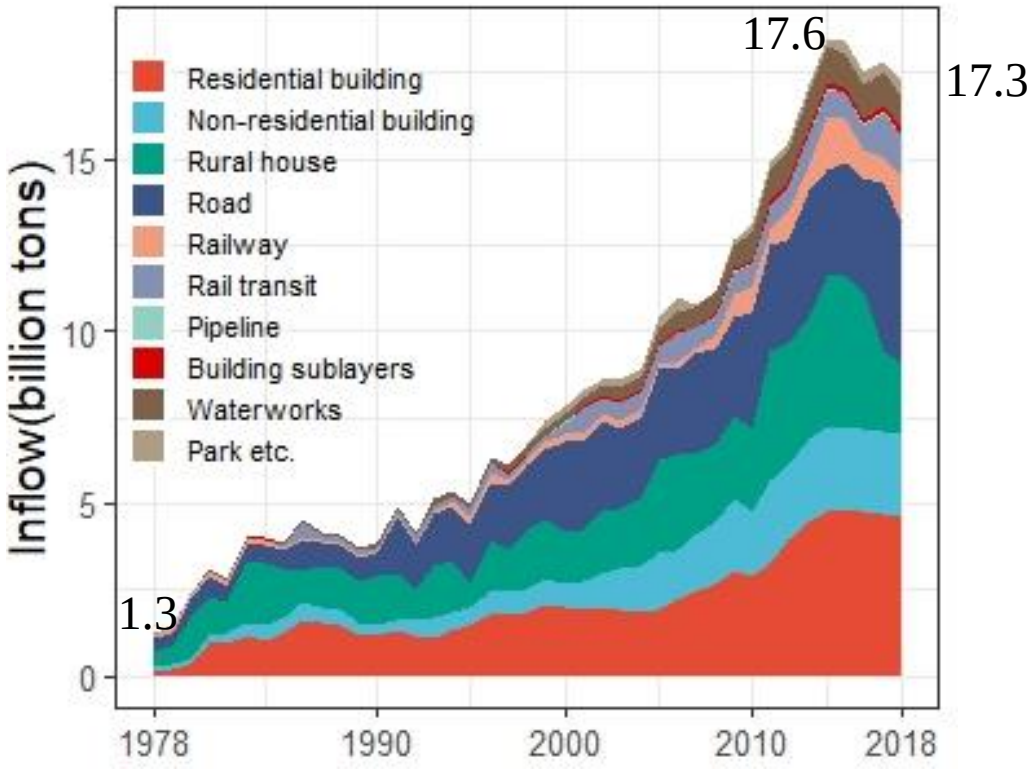
Results Material flow of aggregates in China (2018)



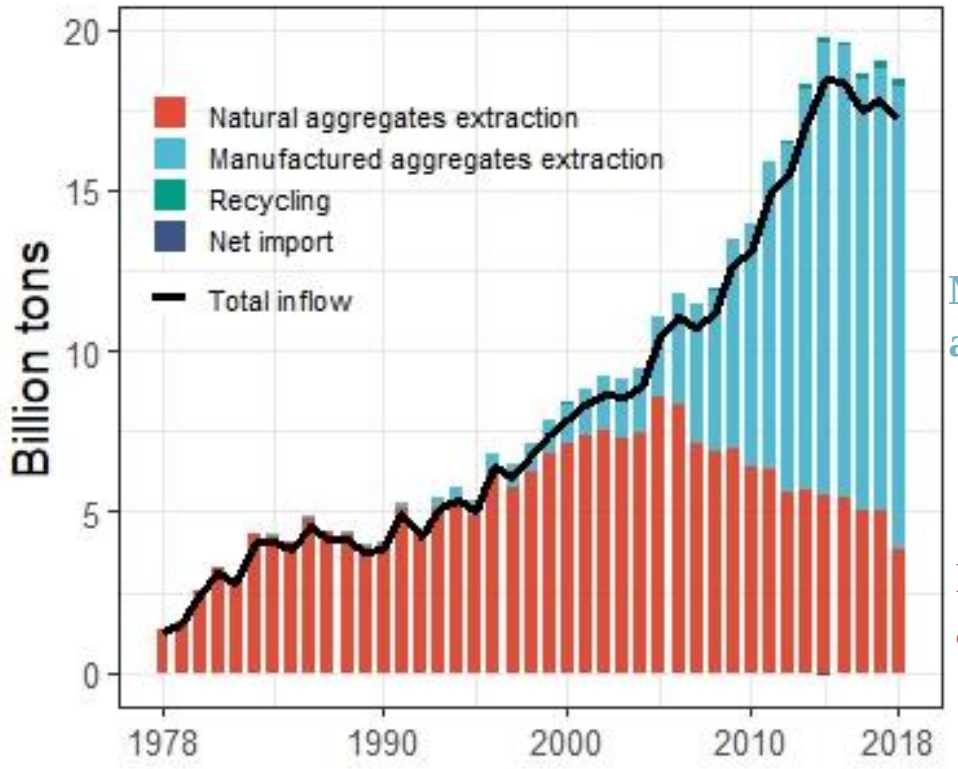
- **Extraction and Processing: Self-sufficiency** from primary aggregates
- **Stock Formation: Buildings** and **transport infrastructure** account for the largest proportion
- **Waste recycling and disposal:** Low recycling rate. Substantial improvements in the recycling of CDW are warranted

Unit: billion tons

Results Inflows of aggregates in China(1978–2018)



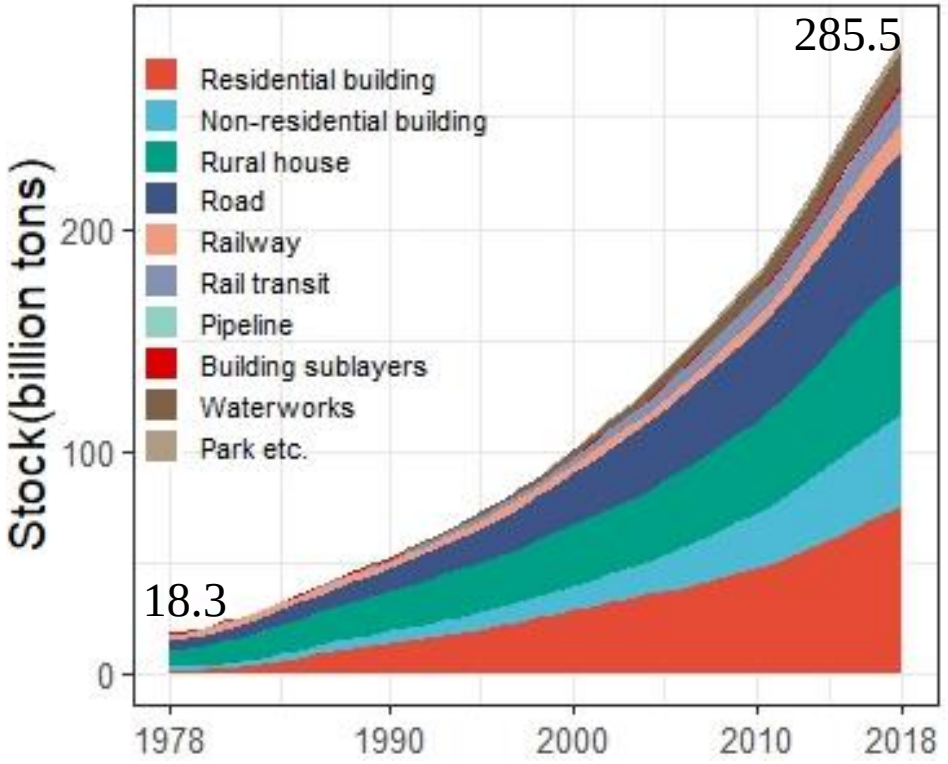
The inflows of different types of aggregates



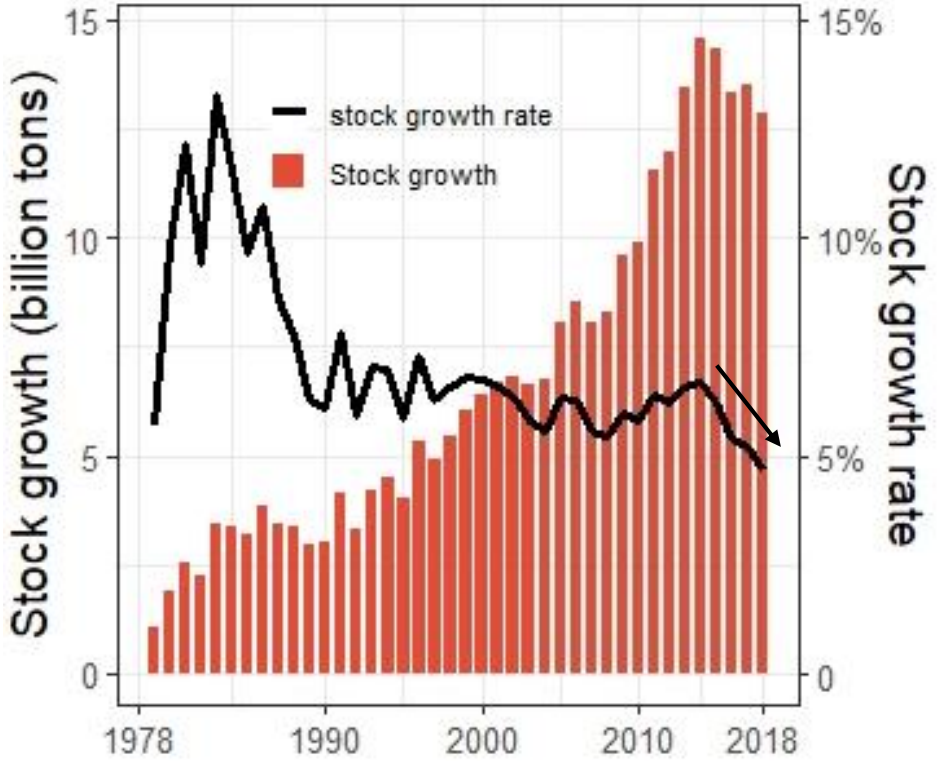
Different **supply sources** of aggregates

- **Large increase:** During 1978-2018, **the inflow** of aggregates increased 13 times (from 1.3 to 17.3 billion tons)
- **Peaking:** The aggregate inflow reached a plateau **in 2014**
- **Sustainable transition on the supply side:** natural aggregates to manufactured aggregates (78% in 2018), overcoming the natural sand crisis

Results Stocks of aggregates in China(1978–2018)



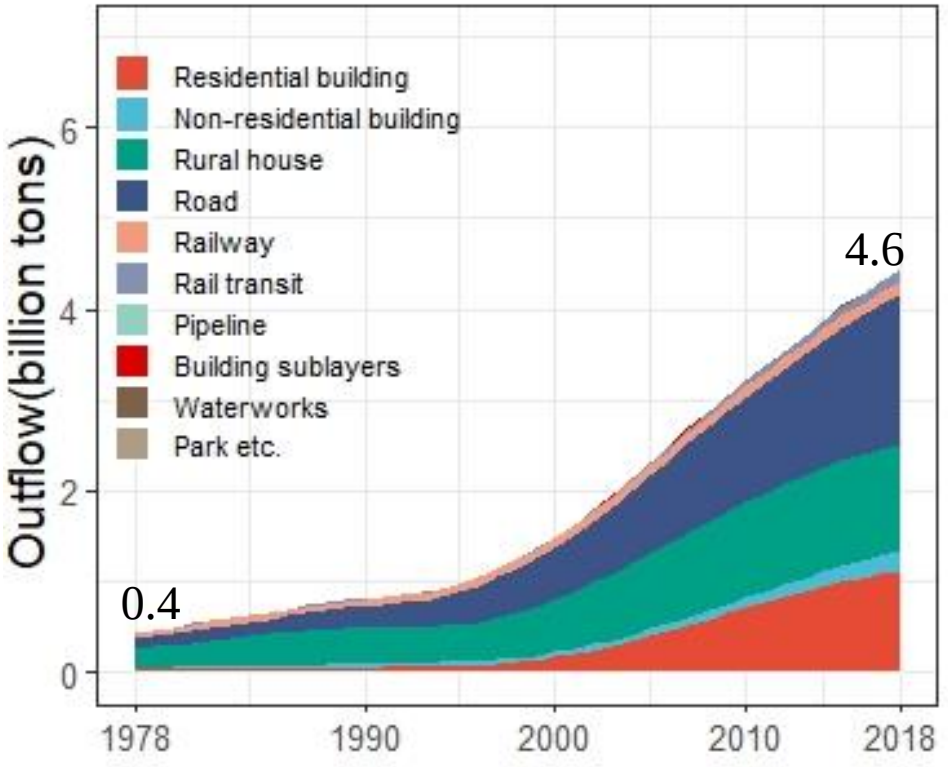
The stocks of different types of aggregates



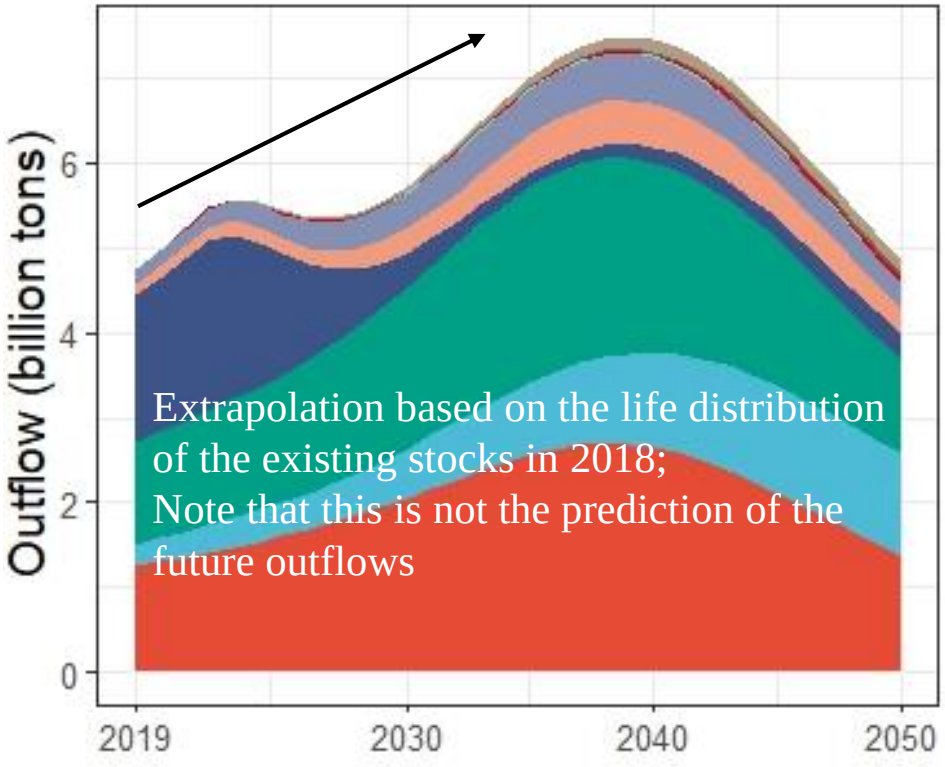
The stock growth and stock growth rate

- **Large increase:** During 1978-2018, **the stocks** of aggregates **increased 15 times** (from 18.3 to 285.5 billion tons)
- **Slow-down growth:** The stock growth rate went down after 2014

Results Outflows of aggregates in China(1978–2018)



The outflows of different types of aggregates



The extrapolation of aggregate outflows to 2050

- **Large increase:** During 1978-2018, **the outflows** of aggregates **increased 13 times** (from 0.4 to 4.6 billion tons)
- **Outflows boom up & Circularity potential: Develop recycled aggregates** as a new source of sand to **overcome the sand crisis** and **decrease the environmental impacts from CDW**

Conclusion and Discussion

- **Large increase and peaking:** China's aggregate consumption experienced a **large increase** since 1978 and **went peaking** in recent years
- **Sustainable transition:** China's aggregate industry see a **sustainable transition on the supply side to manufactured aggregates,** relieving the sand crisis
- **Circularity gaps and recycling potential:** In the coming decades, the **outflow will appear explosive growth**. Government should **establish the recycling mechanism of CDW** to close the circularity gap promoting the sustainable development of sand and gravel resources

Perspective for future research:

- **Deeply look into the recycling potential of different kinds of final uses**
- **Subnational level analysis: Aggregates are always extracted and consumed locally in China**

Thanks for your attention!

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