

Visualization of Coronavirus Disease 2019 Spread Based on Spread Index and Extinction Index

Song-Hai Zhang*, Yun Cai, Jian Li

Content

01

Background

02

Method

03

Case Study

04

Summary

Science China Information Sciences

Content

01

Background

02

Method

03

Case Study

04

Summary

Science China Information Sciences

01 Background



Novel coronavirus (COVID-19) situation as of 24 February 2020, 16:00 (CET)



79,407

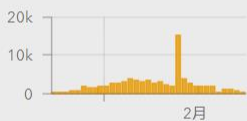
total cases*

2,622
deaths

32

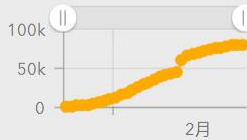
countries with cases

Cases by date of report

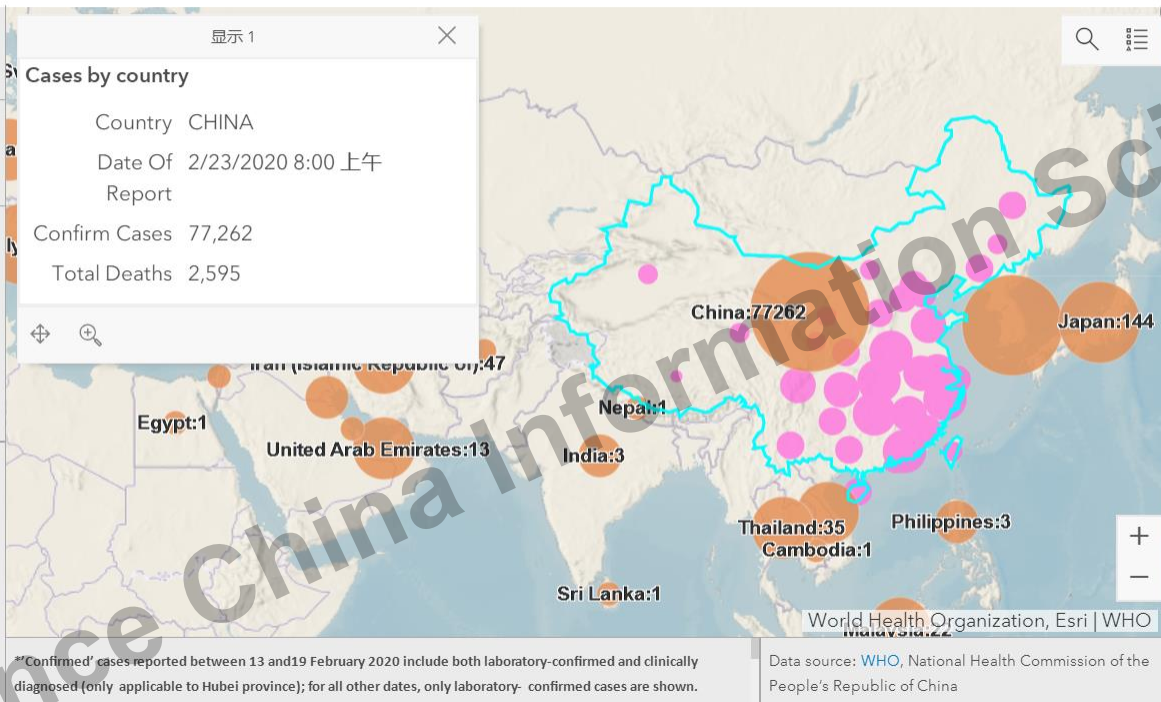


Date of reporting

Cumulative cases



Date of reporting



Countries with confirmed cases

China : 77,262 Cases
Republic of Korea : 833 Cases
International conveyance (Diamond Princess) : 695 Cases
Japan : 144 Cases
Italy : 124 Cases
Singapore : 89 Cases
Iran (Islamic Republic of) : 47 Cases
Thailand : 35 Cases
United States of America : 35 Cases
Australia : 22 Cases
Malaysia : 22 Cases
Germany : 16 Cases
Viet Nam : 16 Cases

◀ Countries, territories ▶

In the winter of 2019, a serious public health event occurred, which was later recognized as a new virus outbreak by WHO and named **Coronavirus Disease 2019 (COVID-19)**

01 Background



Novel coronavirus (COVID-19) situation as of 24 February 2020, 16:00 (CET)



79,407

total cases*

2,622
deaths

32
countries with cases

Cases by date of report

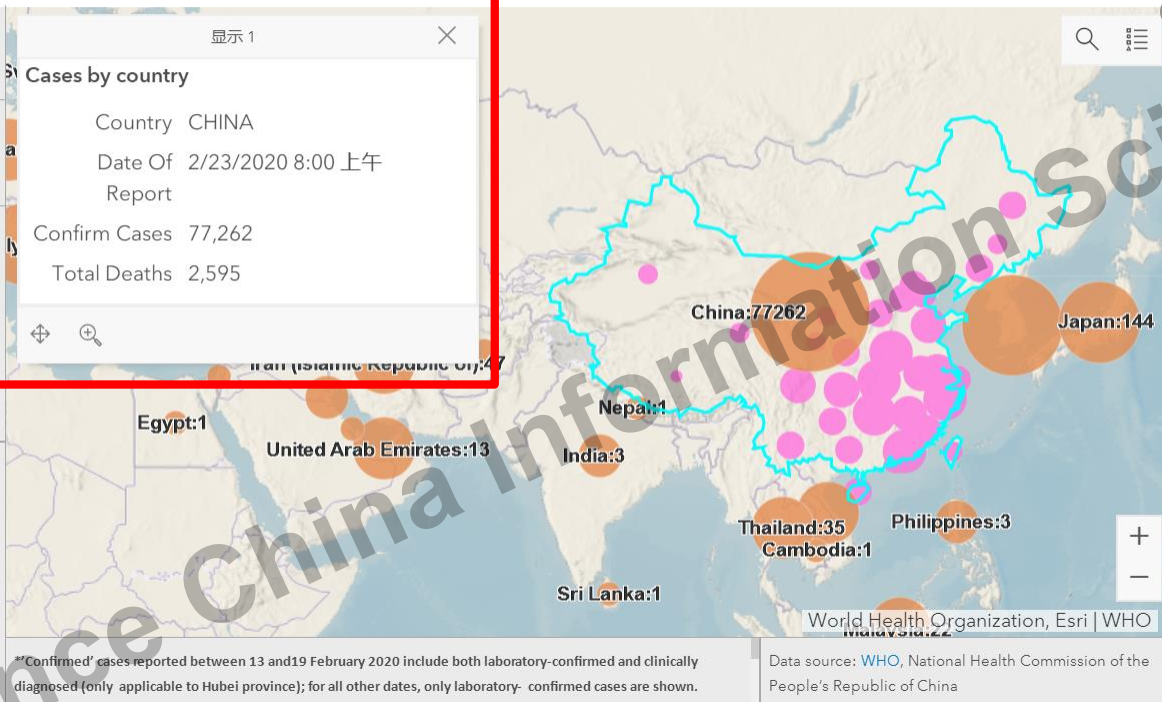


Date of reporting

Cumulative cases



Date of reporting



Countries with confirmed cases

China : 77262 Cases
Republic of Korea : 833 Cases
International conveyance (Diamond Princess) : 695 Cases
Japan : 144 Cases
Italy : 124 Cases
Singapore : 89 Cases
Iran (Islamic Republic of) : 47 Cases
Thailand : 35 Cases
United States of America : 35 Cases
Australia : 22 Cases
Malaysia : 22 Cases
Germany : 16 Cases
Viet Nam : 16 Cases

◀ Countries, territories ▶

So far more than 70,000 people have been infected, and more than 2,000 have died.

01 Background



Novel coronavirus (COVID-19) situation as of 24 February 2020, 16:00 (CET)



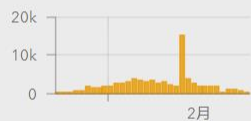
79,407

total cases*

2,622
deaths

32
countries with cases

Cases by date of report

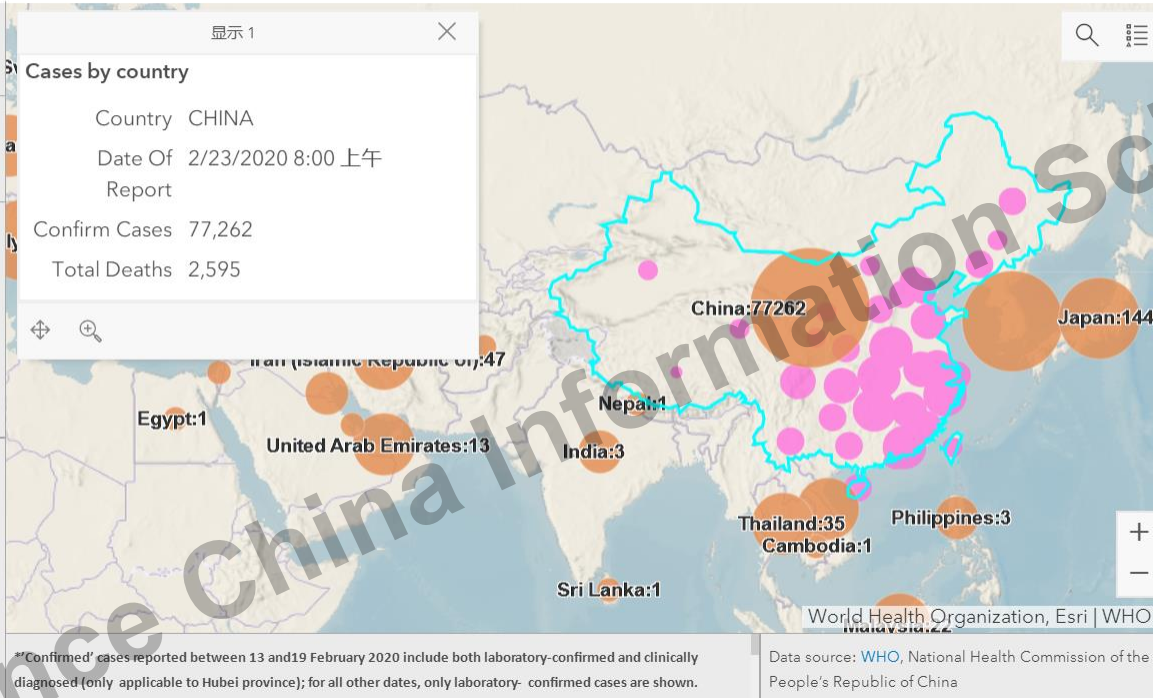


Date of reporting

Cumulative cases



Date of reporting



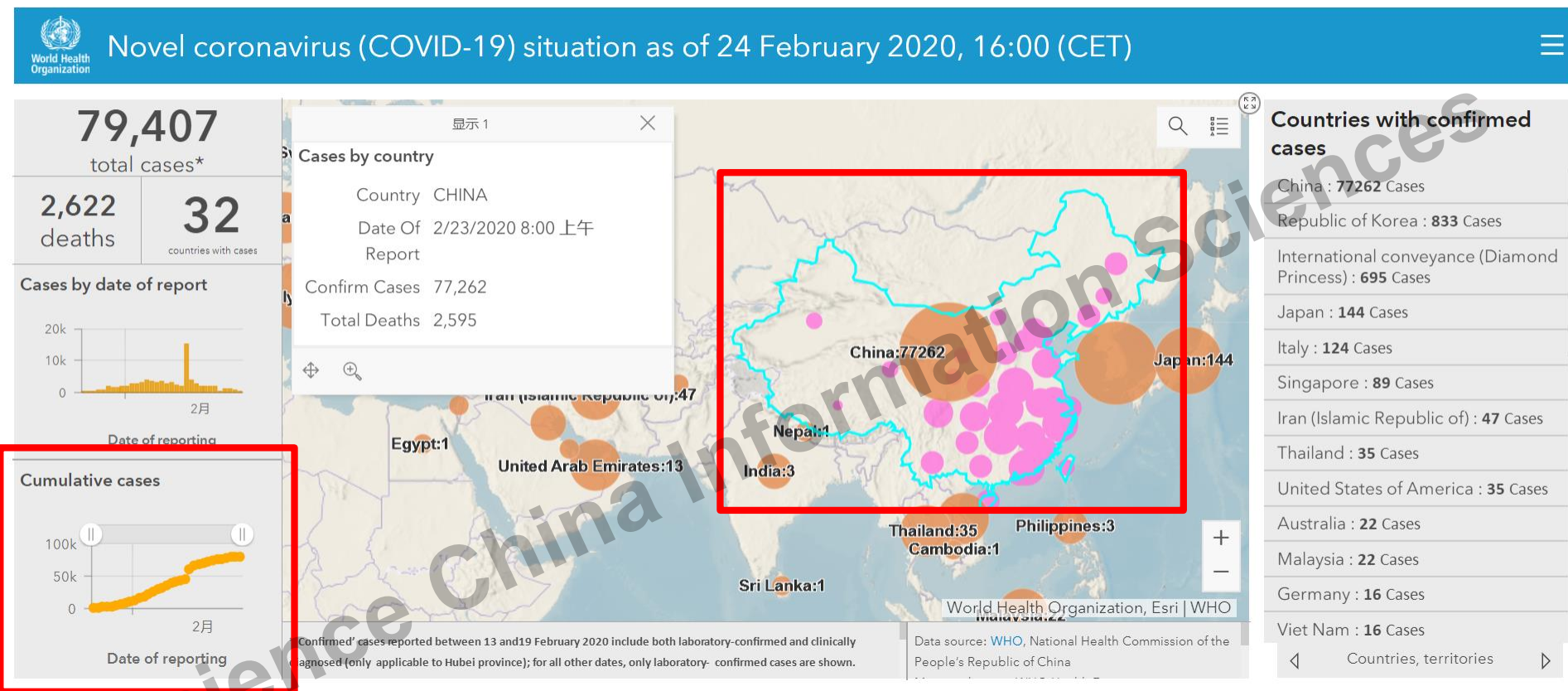
Countries with confirmed cases

China : 77,262 Cases
Republic of Korea : 833 Cases
International conveyance (Diamond Princess) : 695 Cases
Japan : 144 Cases
Italy : 124 Cases
Singapore : 89 Cases
Iran (Islamic Republic of) : 47 Cases
Thailand : 35 Cases
United States of America : 35 Cases
Australia : 22 Cases
Malaysia : 22 Cases
Germany : 16 Cases
Viet Nam : 16 Cases

◀ Countries, territories ▶

Moreover, COVID-19 has already spread to 28 countries, and is causing new outbreaks in certain countries, such as Japan, Korea, Iran and Italy.

01 Background



The influence of COVID-19 has already exceeded that of SARS in 2003. Its spread is **rapid** and extremely **unbalanced**, spanning **four orders of magnitude** in the number of infections in different cities.

01 Background

While classical epidemiological modeling is clearly important, the spread of COVID-19 has been influenced by several factors such models do not necessarily account for

- travel from Wuhan to other cities during the Spring Festival
- airborne transmission without contact
- blockade policies of governments



武汉迁出目的地		
① 文字解读		
名称	比例	
1 湖北省	70.67%	
2 河南省	6.22%	
3 湖南省	3.36%	
4 安徽省	2.27%	
5 江西省	2.09%	
6 广东省	1.66%	
7 重庆市	1.27%	

Such influences make it quite difficult to predict the spread of COVID-19. One chance event can lead to large consequences.

Content

01

Background

02

Method

03

Case Study

04

Summary

Science China Information Sciences

02 Method

We design an intuitive visualization system which allows unprofessional members of the public to grasp the key ideas at a glance.

End User

- The public not expert in data analysis
- Limited time to read the results

Collected Data

- Source: Official release from Health Commission and Bureau of Statistics
- Type: the **total number** of and **daily increasing** in **confirmed** cases, the number **cured**, and the number who have **died**
- the resident **population**, area...



中华人民共和国国家卫生健康委员会
National Health Commission of the People's Republic of China



国家统计局
National Bureau of Statistics



湖北省卫生健康委员会
Health Commission of Hubei Province



湖北省统计局
Hubei Provincial Bureau of Statistics

疫情通报

- 截至2月27日24时新型冠状病毒肺炎疫情最新情况
- 截至2月26日24时新型冠状病毒肺炎疫情最新情况
- 截至2月25日24时新型冠状病毒肺炎疫情最新情况
- 截至2月24日24时新型冠状病毒肺炎疫情最新情况
- 截至2月23日24时新型冠状病毒肺炎疫情最新情况
- 截至2月22日24时新型冠状病毒肺炎疫情最新情况

更多>

信息发布

- 湖北省新冠肺炎疫情防控指挥部物资保障组医用防护物资分配情况公示(2月27日) 2020-02-28
- 2020年2月27日湖北省新冠肺炎疫情情况 2020-02-28
- "新型冠状病毒感染的肺炎疫情防控工作"新闻发布会第三十三场 2020-02-27

地区	2019年1-2月	2019年1-2月	2019年1-2月	2019年1-2月	2019年1-2月
全国	1375.80	1059.20	1362.80	1345.20	1333.40
北京	1081.63	1049.00	1044.40	1026.00	1016.66
广东	881.80	873.29	1038.00	1026.84	1024.93
江苏	376.72	368.17	370.24	367.39	366.74
河南	245.85	242.85	240.87	236.58	237.88
浙江	740.00	736.00	734.40	730.41	730.84
山东	595.21	584.00	585.00	585.56	584.26
湖北	791.20	748.00	753.43	753.00	751.50
四川	581.54	555.00	562.05	561.37	567.23
上海	1462.00	1455.13	1450.00	1442.97	1439.69
湖南	696.94	680.67	682.79	683.40	684.72
陕西	774.10	753.88	758.00	753.00	751.76
天津	602.86	590.93	590.94	586.57	583.78

02 Method

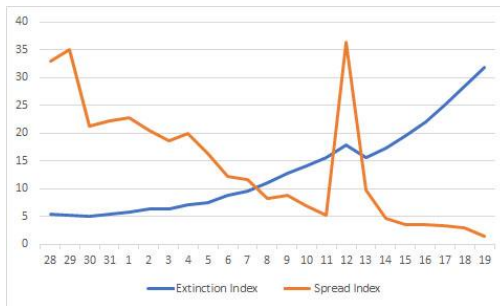
We design an intuitive visualization system which allows unprofessional members of the public to grasp the key ideas at a glance.

End User	Collected Data
<ul style="list-style-type: none">➤ The public not expert in data analysis➤ Limited time to read the results	<ul style="list-style-type: none">➤ Source: Official release from Health Commission and Bureau of Statistics➤ Type: the total number of and daily increasing in confirmed cases, the number cured, and the number who have died➤ the resident population, area...
Visualization System	
<ul style="list-style-type: none">➤ Some indices are proposed which reveal the essence from the raw data➤ Basic statistical charts, ThemeRiver, and bubble charts with no more than 4 visual channels are used, coping well with high dynamic range data varying over 4 orders of magnitude➤ The need for interaction should be avoided	

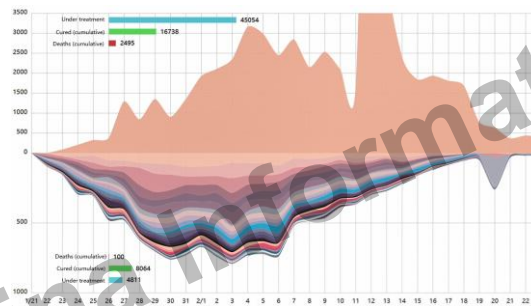
02 Method

We design an intuitive visualization system which allows unprofessional members of the public to grasp the key ideas at a glance.

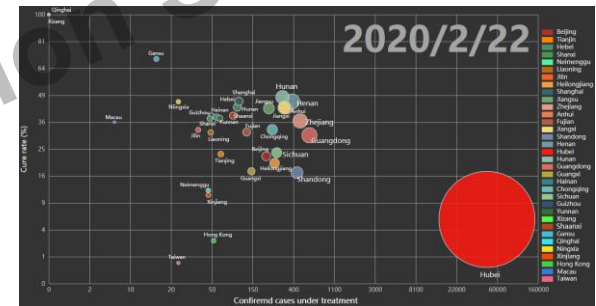
Line charts



ThemeRiver



Bubble charts



Spread Index and Extinction Index

Feb 22 Hubei: 63889 vs. Xizang: 1

Visualization System

- Some indices are proposed which reveal the essence from the raw data
- Basic statistical charts, ThemeRiver, and bubble charts with no more than 4 visual channels are used, coping well with high dynamic range data varying over 4 orders of magnitude
- The need for interaction should be avoided

02 Method

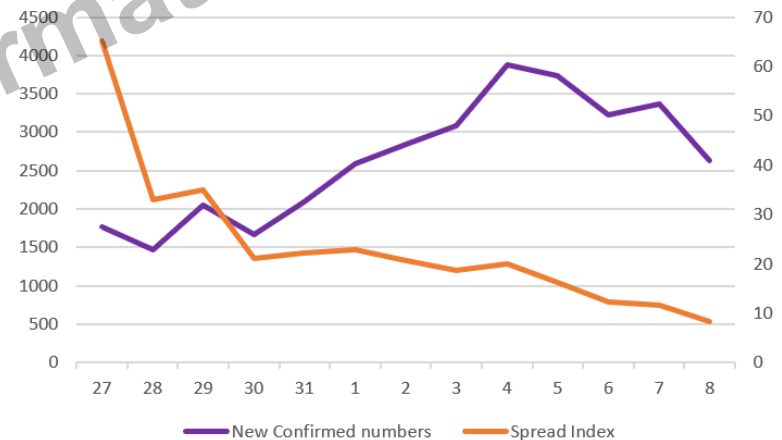
1. Spread Index and Extinction Index

In the early part of the an epidemic spread model, the number of people infected $I(t)$ follows exponential growth.

If $I(t) = ba^t$ in a local domain

Spread Index: $F_s = \frac{I'}{I} = \ln(a)$

Discretely, $F_s(i) = \frac{I(i)}{I_t(i-1)}$
for day i



$I_t(i)$: the number of confirmed cases **under treatment**

$I_s(i)$: the **total number** of confirmed cases

$I(i)$: the number of **new confirmed** cases

$C(i)$ and $D(i)$: increasing in number of persons having been **cured** and having **died**

02 Method

1. Spread Index and Extinction Index

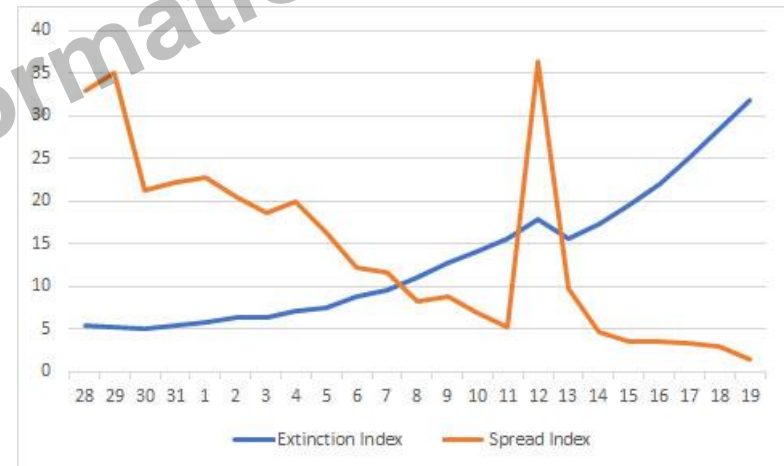
In the early part of the an epidemic spread model, the number of people infected $I(t)$ follows exponential growth.

Spread Index: $F_s(i) = \frac{I(i)}{I_t(i-1)}$

Extinction Index:

$$F_e(i) = \frac{C(i)+D(i)}{I_t(i-1)}$$

for day i



$I_t(i)$: the number of confirmed cases **under treatment**

$I_s(i)$: the **total number** of confirmed cases

$I(i)$: the number of **new confirmed** cases

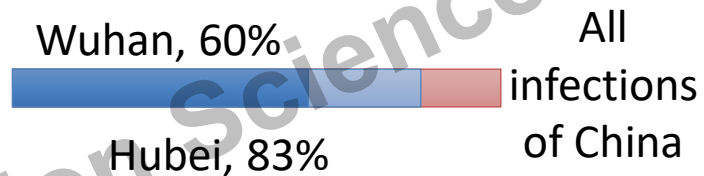
$C(i)$ and $D(i)$: increasing in number of

persons having been **cured** and having **died**

02 Method

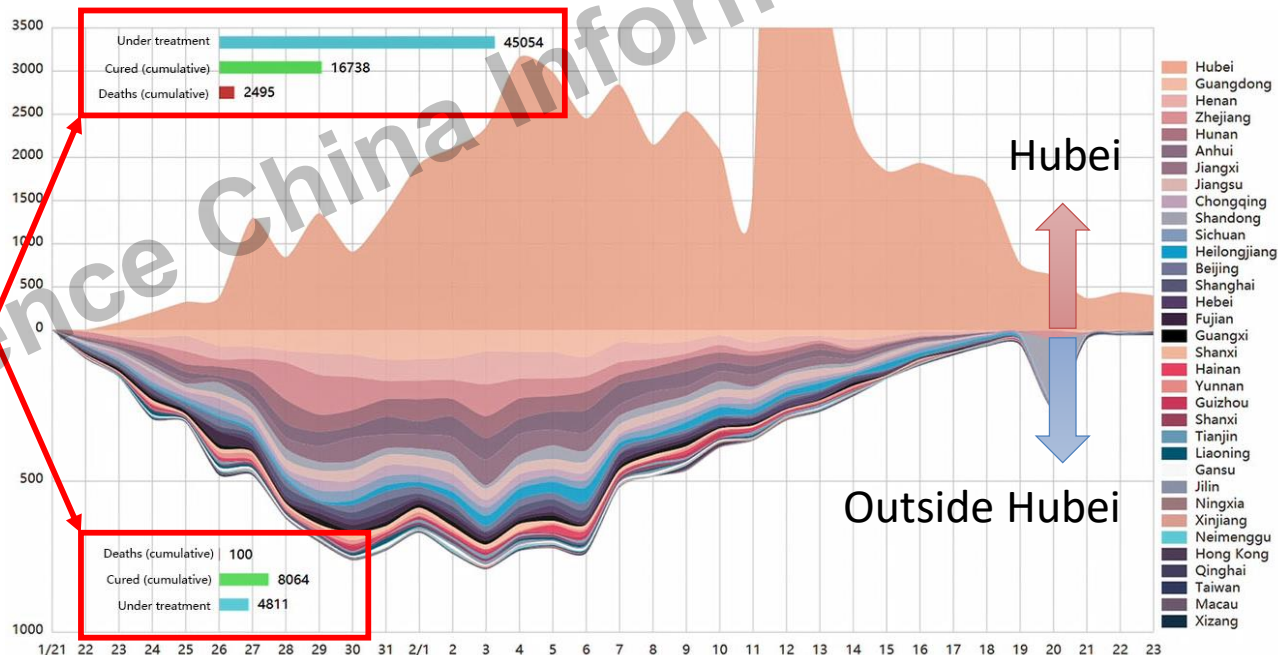
2. ThemeRiver

As noted, the distribution of COVID-19 is extremely unbalanced



We redesign ThemeRiver in three approaches.

Bar charts of the number of confirmed cases under treatment, cured and having died



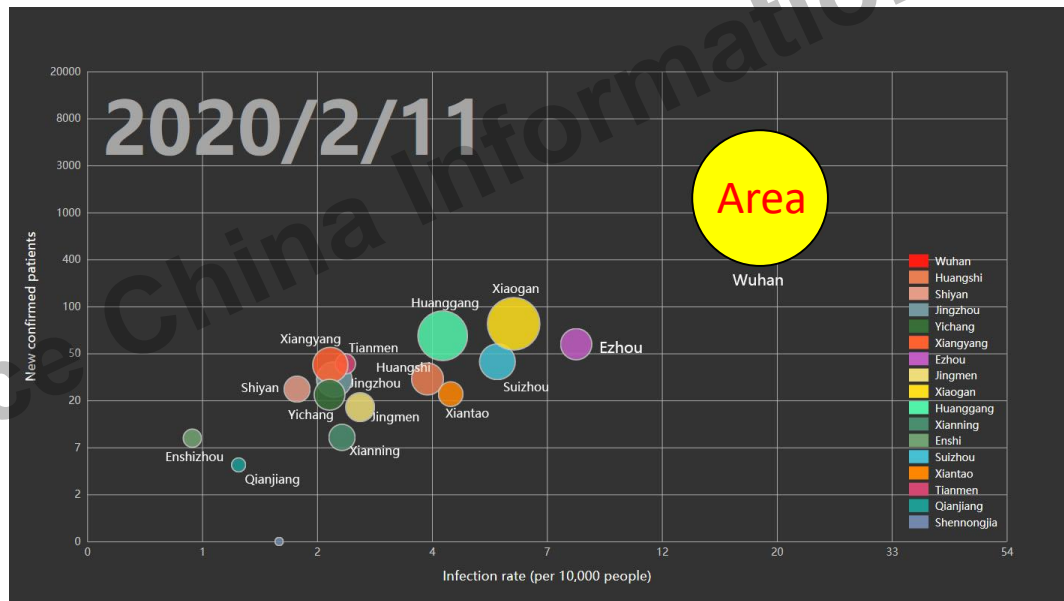
sort in descending order by I_s

02 Method

3. Bubble chart

We use bubble chart animations with only four visual channels: horizontal axis, vertical axis, color and bubble area.

horizontal
axis



horizontal axis

Logarithmic coordinates are used for the two axes and area of the bubble, to handle high dynamic range data.

Content

01

Background

02

Method

03

Case Study

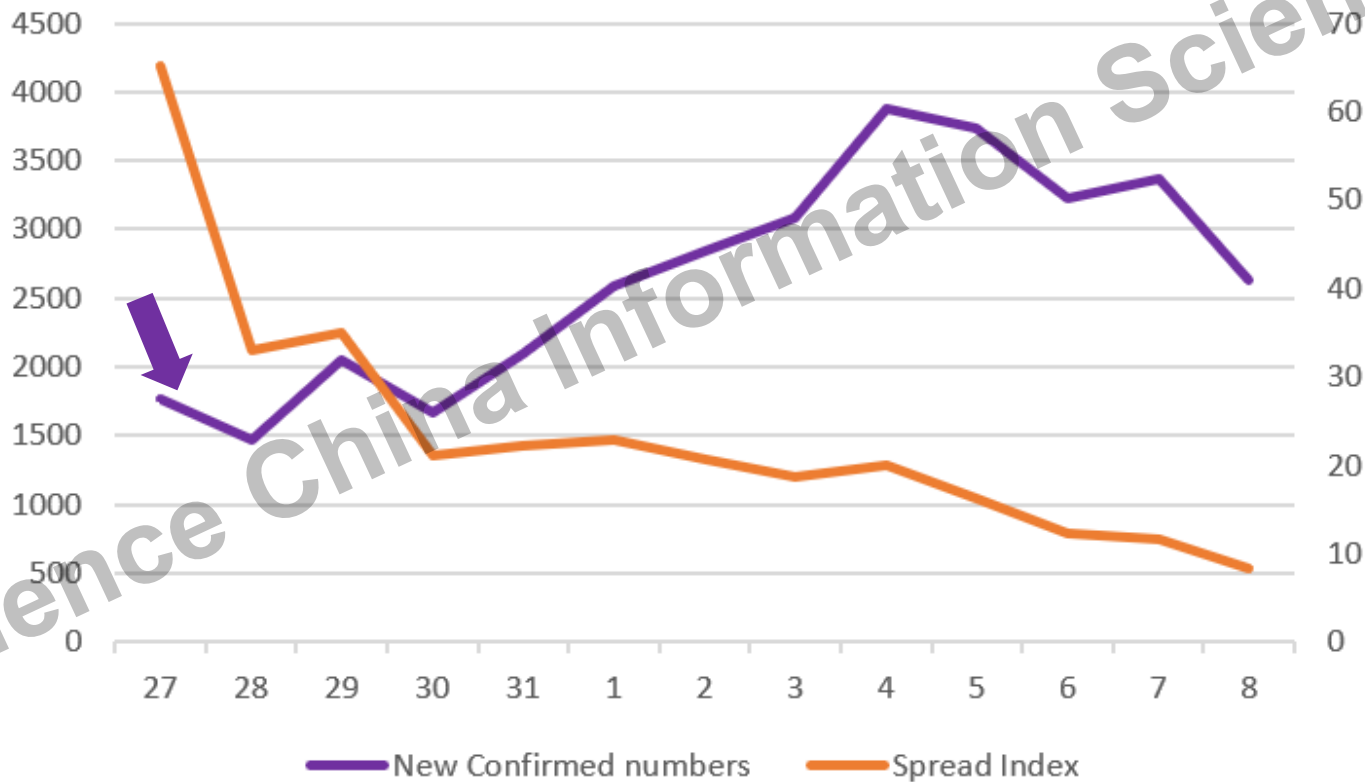
04

Summary

Science China Information Sciences

03 Case Study

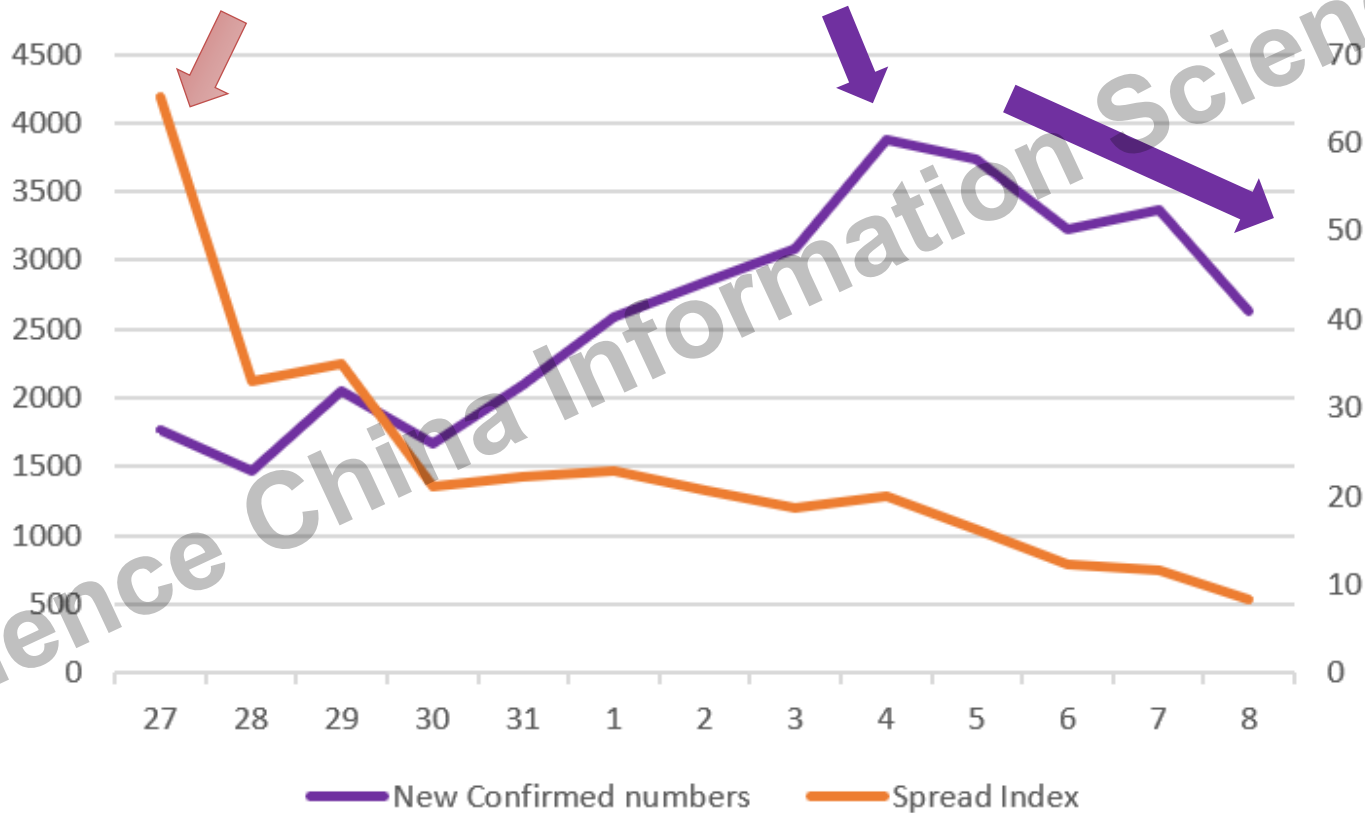
1. New confirmed cases increasing while Spread Index is decreasing



Before 5 February, the number of **new confirmed cases** across the whole of China was **increasing rapidly**, causing public anxiety.

03 Case Study

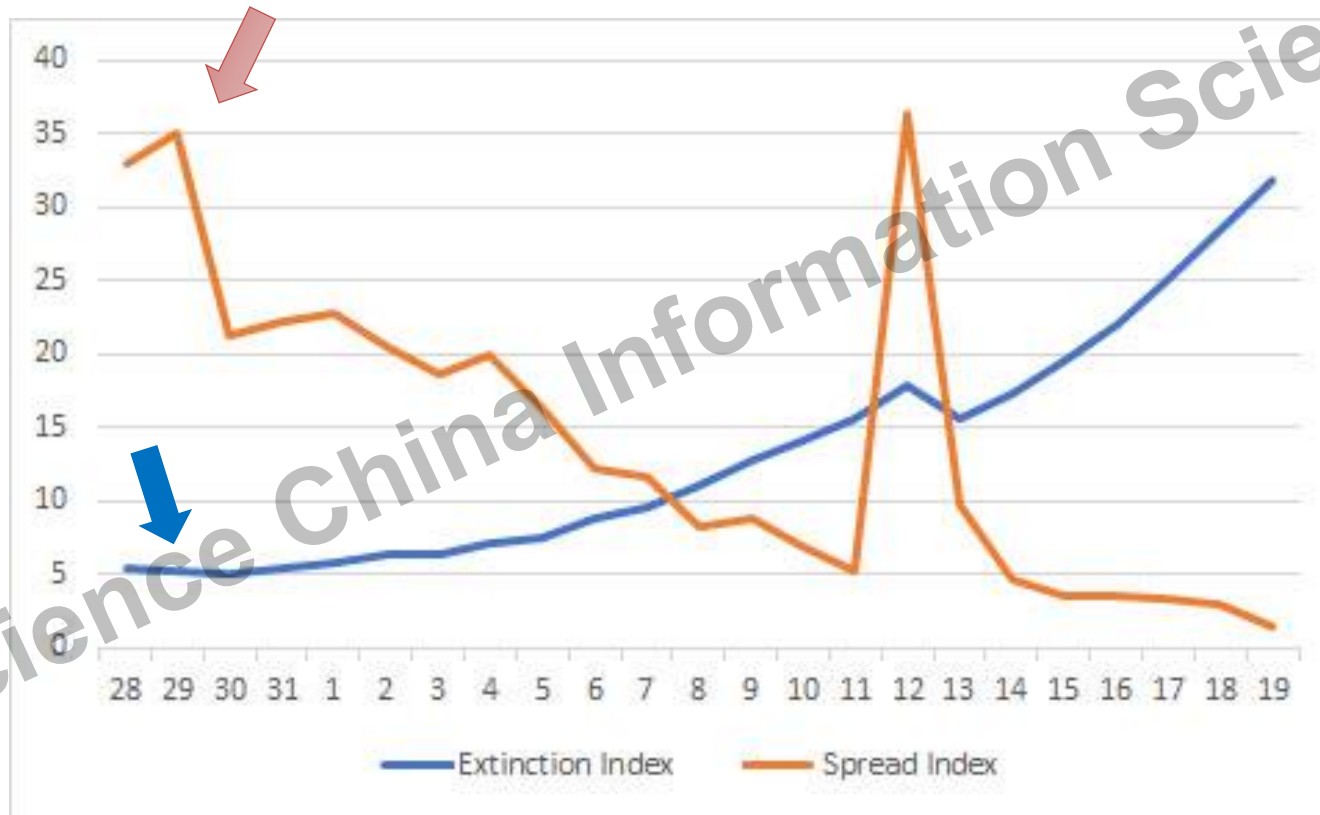
1. New confirmed cases increasing while Spread Index is decreasing



However, the number of new confirmed cases is gradually decreasing, showing that the epidemic is spreading slower and slower.

03 Case Study

2. Balancing point of Spread Index and Extinction Index



The Spread Index curve is descending while the Extinction Index curve is ascending over time.

03 Case Study

2. Balancing point of Spread Index and Extinction Index

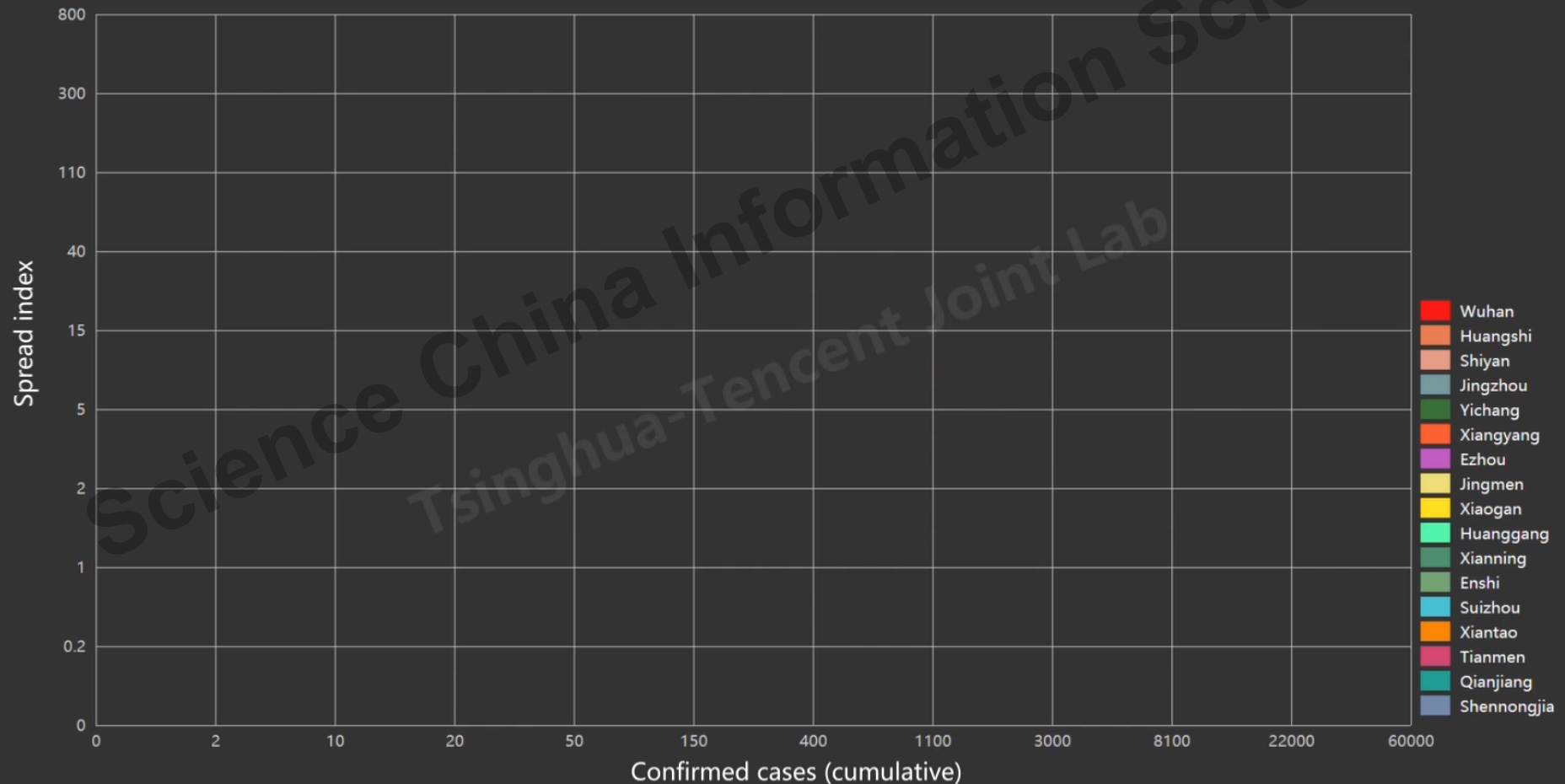


The balancing point was reached on 7th February. Since that, the number of confirmed cases under treatment has been decreasing.

03 Case Study

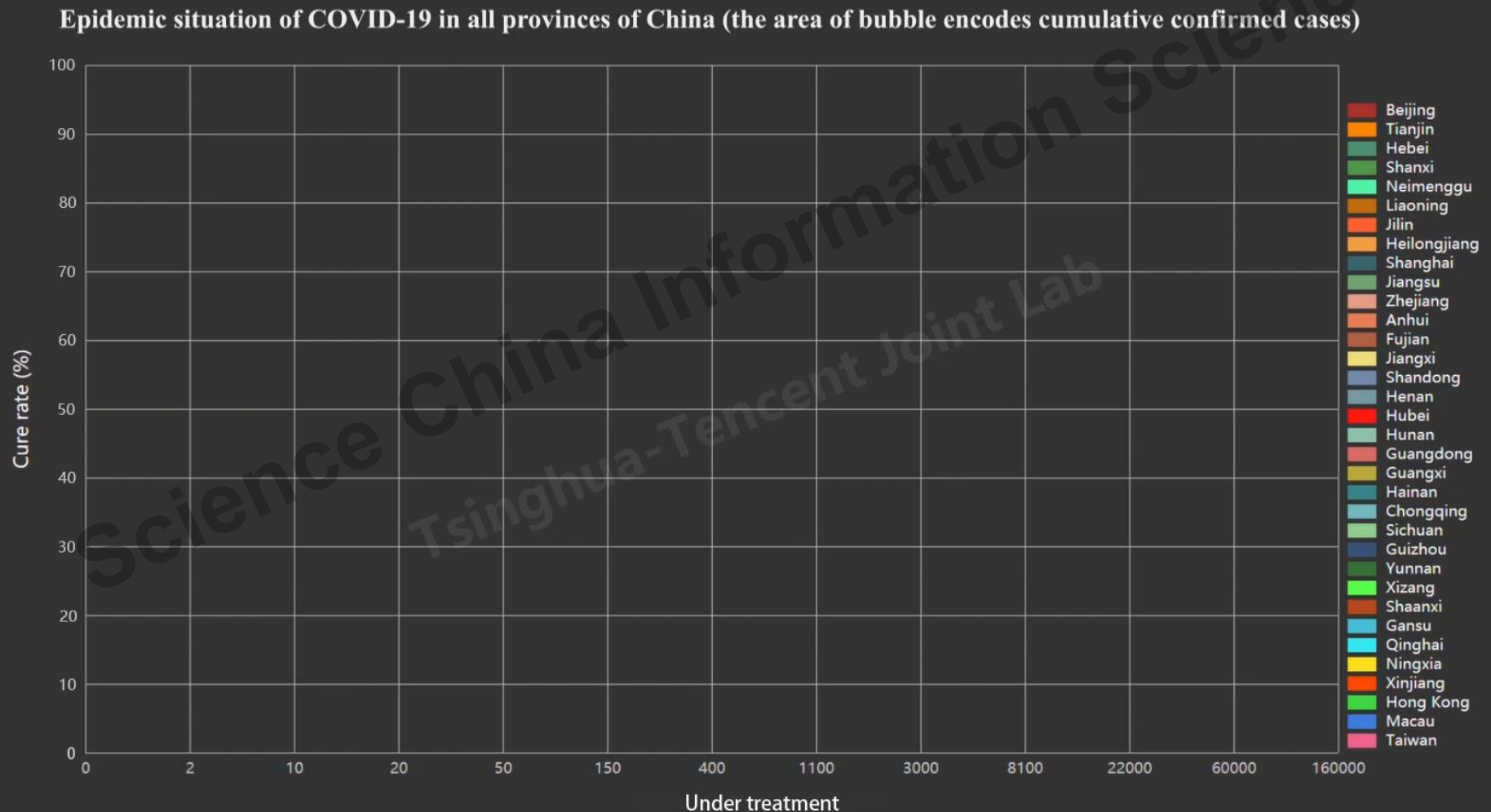
3. High risk of Ezhou from the bubble chart

Epidemic situation of COVID-19 in all cities of Hubei (the area of bubble encodes infection rate)



03 Case Study

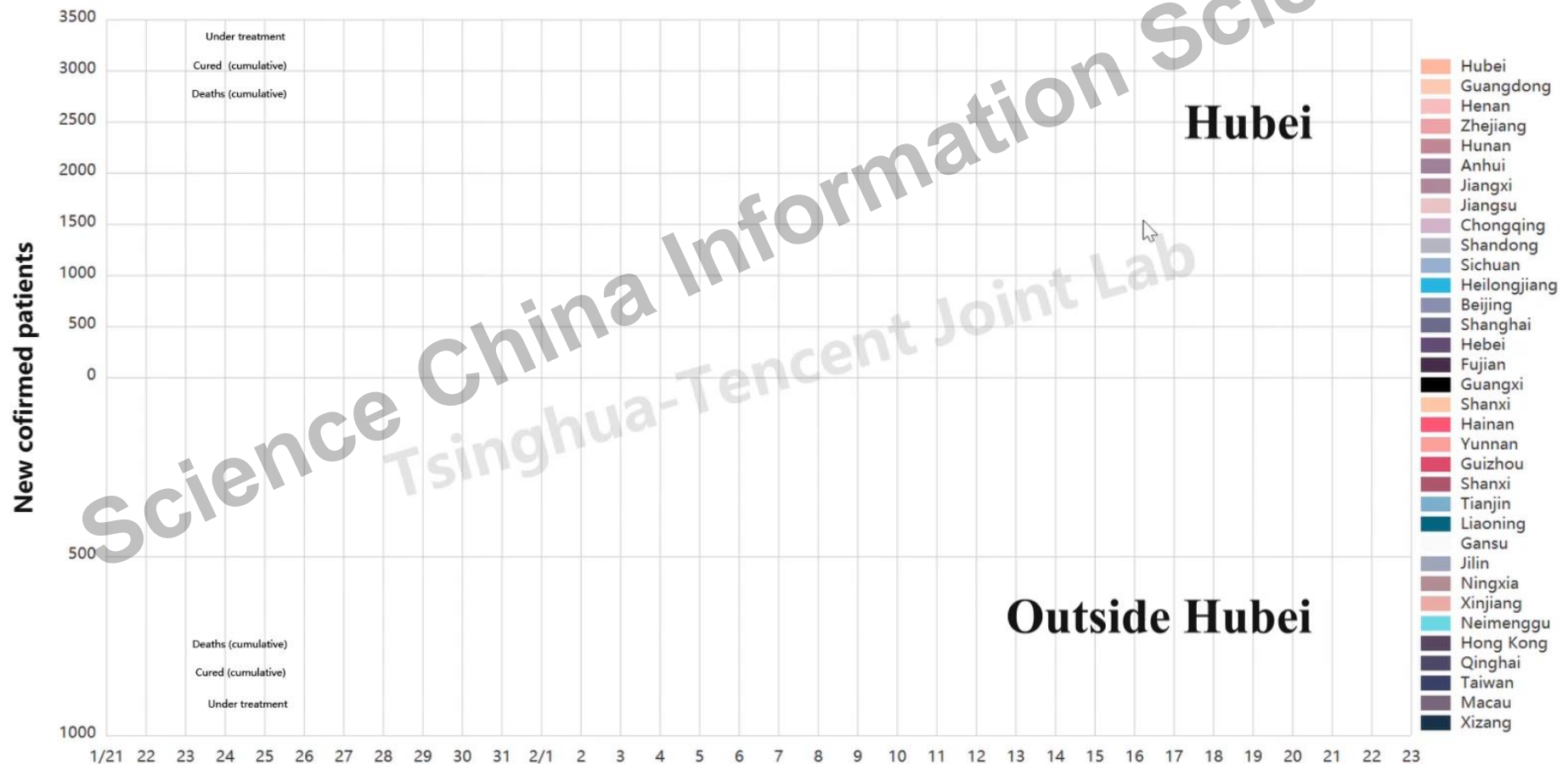
4. The evolution of the epidemic is on the descending phase



03 Case Study

5. Comparison of Hubei and outside Hubei by ThemeRiver

ThemeRiver for epidemic situation of COVID-19 in all provinces of China



Content

01

Background

02

Method

03

Case Study

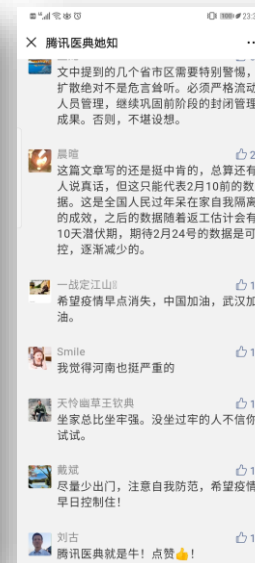
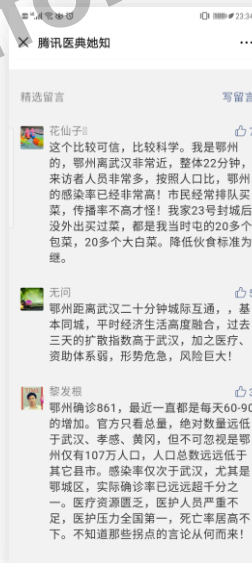
04

Summary

Science China Information Sciences

04 Summary

- This study introduced a system to analyze and visualize the COVID-19 epidemic situation.
- Using this system, daily reports have been published on the Tencent platforms, gaining high public attention with more than 10 million page views (PV).



Animations are recommended on the main page of TencentVideo

Positive comments on the daily reports

THANKS

武汉加油!

中国加油!

Science China Information Sciences