Cluster ranking

The GII reveals the world's top 100 science and technology (S&T) clusters and identifies the most S&T-intensive top global clusters.

The GII 2022 top 100 science and technology clusters

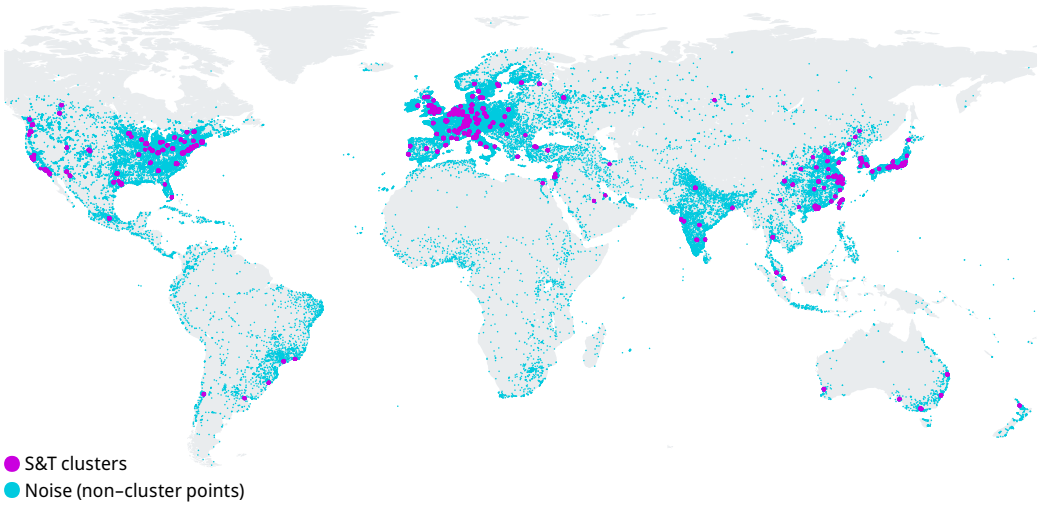
Recognizing that innovation output at the local level is as important as output at the national level, the Global Innovation Index (GII) continues to present the world's largest top 100 science and technology (S&T) clusters (see Map 1) – that is, the geographical areas around the world with the highest density of inventors and scientific authors (see Appendix IV, which details the methodological adjustment employed).

For the first time, this year the GII also presents S&T clusters beyond the top 100, shedding light on those clusters not normally highlighted in the section.

Tokyo–Yokohama continues to lead the top 100 S&T clusters

Among the top 100, Tokyo–Yokohama (Japan) is the top-performing cluster, followed by Shenzhen–Hong Kong–Guangzhou (China and Hong Kong, China), Beijing (China), Seoul (Republic of Korea) and San Jose–San Francisco (United States) (see Appendix Table 3).
The top 10 clusters remain the same as last year, with one difference: Shanghai and Suzhou have now merged into one cluster.

Map 1 Top 100 clusters worldwide, 2022



Source: WIPO Statistics Database, April 2022.
Note: Noise refers to all inventor/author locations not classified in a cluster.

The largest increases in the ranking came from three Chinese clusters – Zhengzhou (+15 positions), Qingdao (+12) and Xiamen (+12). Berlin (+4) in Germany, Istanbul (+4) in Türkiye, Kanazawa (+4) in Japan, Ankara (+3) in Türkiye, Daegu (+3) in the Republic of Korea and Mumbai (+3) in India also advanced strongly this year.

Chinese clusters experienced the largest increases in S&T output too, with the median increase equating to +13.9 percent and with China hosting the fastest growing clusters – Qingdao (+25.2 percent) and Wuhan (+21.9 percent).[1] Other clusters in middle-income economies, besides those in China, also experienced strong growth, including Istanbul (Türkiye, +7.3 percent), Chennai (India, +7.1 percent) and Delhi (India, +5.2 percent).

High-income economy clusters generally grew at a slower pace than clusters in middle-income economies. However, there were some notable exceptions among the high-income economy clusters, namely Basel (+10.5 percent), a new top 100 entrant this year from the French, German and Swiss border region, Munich (+8.6 percent) in Germany – closing the gap between it and Cologne – and Kanazawa (+8.1 percent) in Japan.

The top S&T clusters of each economy or cross-border region are shown in Table 6.

Table 6 Top S&T cluster of each economy or cross-border region, rank among the top 100, 2022

Rank	Cluster name	Economy	Rank change since 2021
1	Tokyo–Yokohama	JP	0
2	Shenzhen–Hong Kong–Guangzhou	CN/HK	0
3	Beijing	CN	0
4	Seoul	KR	0
5	San Jose–San Francisco, CA	US	0
10	Paris	FR	0
19	London	GB	0
23	Cologne	DE	−2
25	Amsterdam–Rotterdam	NL	−2
26	Taipei–Hsinchu	TW	0
30	Tel Aviv–Jerusalem	IL	−2
31	Moscow	RU	−1
32	Tehran	IR	0
33	Singapore	SG	−2
35	Stockholm	SE	0
36	Eindhoven	NL/BE	−2
39	Melbourne	AU	−2
46	Istanbul	TR	4
47	Brussels	BE	−4
48	Madrid	ES	−1
51	Zürich	CH/DE	1
53	Milan	IT	0
54	Toronto, ON	CA	−5
59	Copenhagen	DK	−4
60	Bengaluru	IN	0
71	São Paulo	BR	0
73	Helsinki	FI	−1
76	Vienna	AT	−1
92	Warsaw	PL	0
93	Lausanne	CH/FR	−3
99	Basel	CH/DE/FR	7

Source: WIPO Statistics Database, April 2022.

Notes: The codes given in the tables in this section are the ISO alpha-2 country codes, with the following addition: TW = Taiwan Province of China.

China is now on a par with the United States in terms of the number of top 100 S&T clusters

In 2022, as in previous years, the top 100 S&T clusters are highly concentrated in three regions, Northern America, Europe and Asia and, especially, in two countries: the United States and China (see Map 1).

For the first time, China hosts as many clusters as the United States, with 21 each (see Map 2a and 2b and Table 7). Germany follows, with 10 clusters in the top 100, with Cologne and Munich as the two largest clusters. Japan has five clusters in the top 100, with Tokyo–Yokohama and Osaka–Kobe–Kyoto also represented in the top 10 clusters overall.

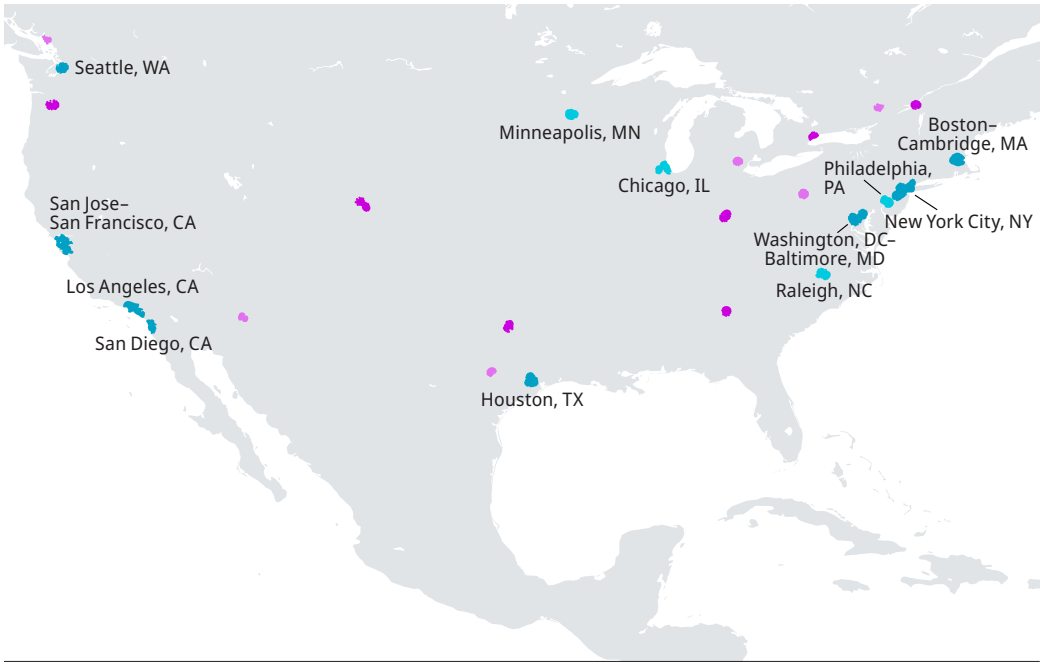
Mirroring last year's results, with the exception of China, only five middle-income economies have clusters in the top 100:

- Brazil (1 cluster), with São Paulo, the sole top 100 S&T cluster in Latin America;
- India (4), with Bengaluru, Delhi and Mumbai, as last year, and Chennai making the top 100 for the first time;
- the Islamic Republic of Iran (1), with Tehran;
- Türkiye (2), with Istanbul and Ankara; and
- the Russian Federation (1), with Moscow.

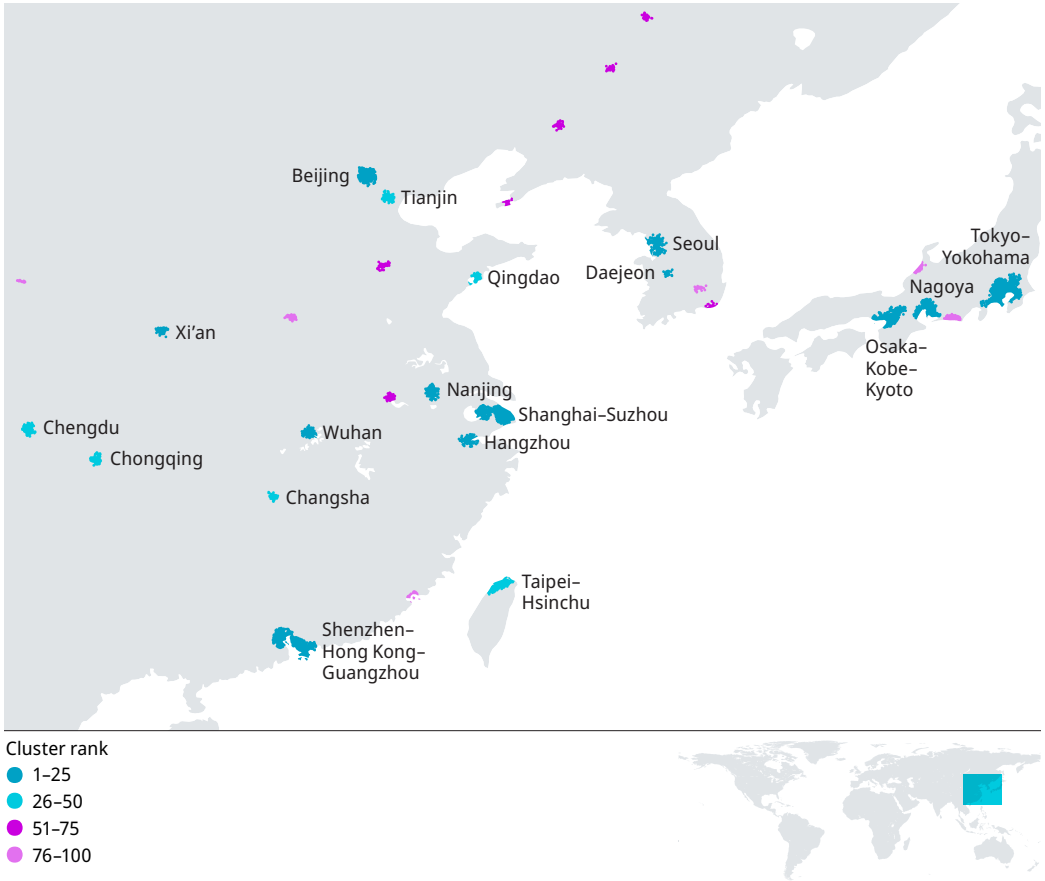
It is notable that, among the aforementioned clusters, Ankara and Istanbul, the two Turkish clusters, and Mumbai have made significant jumps forward.

Map 2 Top S&T clusters, United States and China, 2022

a – United States and Canada



b – East Asia



Source: WIPO Statistics Database, April 2022.

Table 7 Economies with three or more top 100 S&T clusters, 2022

Economy	Economy name	Number of top 100 clusters
US	United States	21
CN	China	21
DE	Germany	10
JP	Japan	5
FR	France	4
CA	Canada	4
IN	India	4
KR	Republic of Korea	4
GB	United Kingdom	3
AU	Australia	3
CH	Switzerland	3
SE	Sweden	3

Source: WIPO Statistics Database, April 2022.

Beyond the top 100: Bangkok, Buenos Aires, Cairo, Kuala Lumpur and Mexico City are top S&T clusters in middle-income economies

Using the same thresholds employed for the identification of top 100 S&T clusters, the GII 2022 also identifies clusters beyond the top 100 without determining their precise ranking.

Based on the same parameters applied to produce the top 100 ranking, 123 additional clusters are identified beyond the top 100, including 23 clusters based in the United States, 13 in both China and Germany and 10 in both France and the United Kingdom.

In India, Kolkata, Pune and Hyderabad stand out. Brazil's Rio de Janeiro and Porto Alegre were also added, along with Saint Petersburg and Novosibirsk in the Russian Federation.

Table 8 identifies top S&T clusters in economies not covered previously in the top 100, including Portugal and Saudi Arabia, with two clusters each. Among the middle-income economies, Argentina, Egypt, Malaysia, Mexico and Thailand each host a top S&T cluster in the extended list, namely Buenos Aires, Cairo, Kuala Lumpur, Mexico City and Bangkok, respectively. Other prominent Latin American urban areas – such as Mexico City, Rio de Janeiro, Porto Alegre and Santiago de Chile – feature in this extended list as well.

Table 8 Top S&T clusters in extended ranking, economies not covered in top 100, 2022

Economy	Economy name	Cluster name
PT	Portugal	Lisbon and Porto
SA	Saudi Arabia	Riyadh and Dammam
AR	Argentina	Buenos Aires
CL	Chile	Santiago
CZ	Czech Republic	Prague
EG	Egypt	Cairo
GR	Greece	Athens
HU	Hungary	Budapest
IE	Ireland	Dublin
MO	Macao, China	Macau
MY	Malaysia	Kuala Lumpur
MX	Mexico	Mexico City
NZ	New Zealand	Auckland
NO	Norway	Oslo
RO	Romania	Bucharest
RS	Serbia	Belgrade
TH	Thailand	Bangkok

Source: WIPO Statistics Database, April 2022.

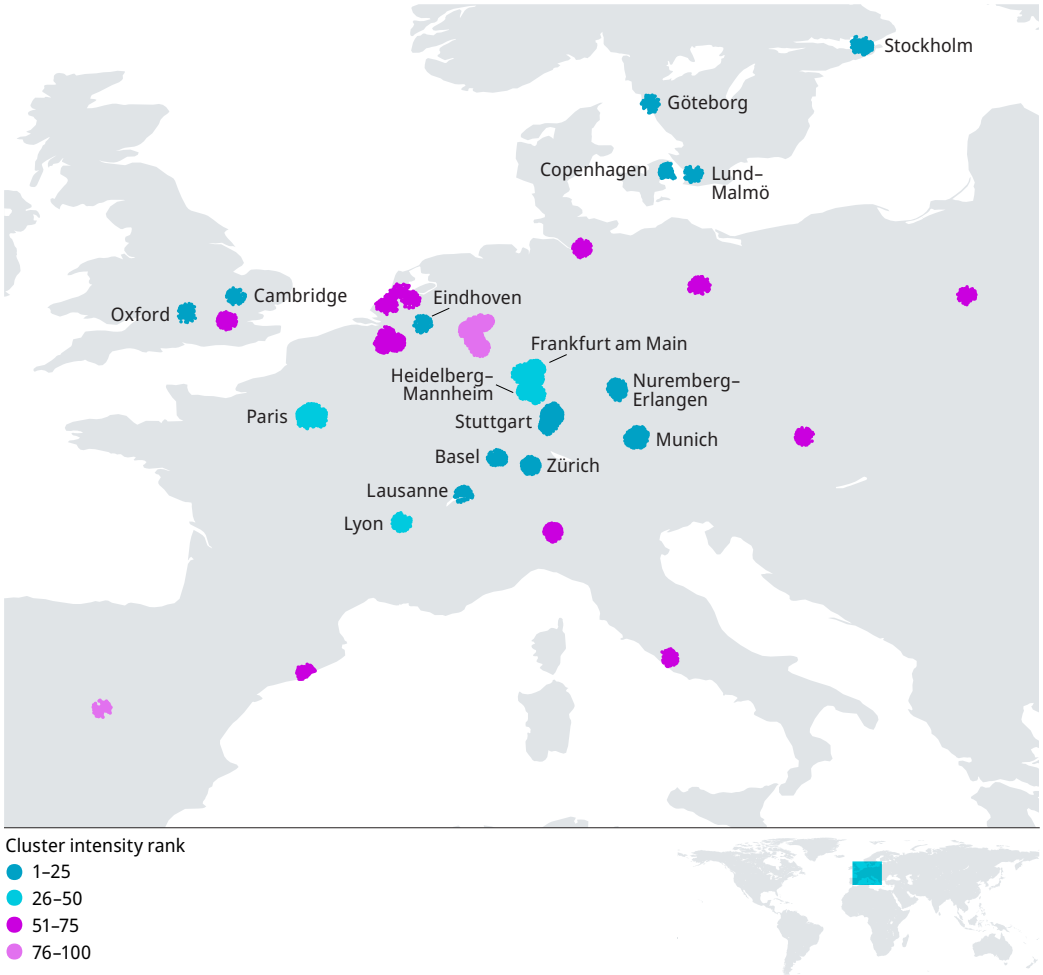
S&T intensity of the top 100 clusters

Since 2020, the GII has also presented the top 100 clusters ranked by their S&T intensity – that is, the sum of their patent and scientific publication shares divided by population. This work draws on geospatial imagery to estimate the underlying population levels (see Appendix IV).

Cambridge in the United Kingdom and Eindhoven in the Netherlands/Belgium are found to be the most S&T-intensive clusters, followed by Daejeon (Republic of Korea), San Jose–San Francisco (United States) and Oxford (United Kingdom) (see Appendix Table 4). Sweden is making a strong showing overall with Lund–Malmö, Stockholm and Göteborg. Only San Jose–San Francisco makes the top five of the GII S&T cluster and the GII S&T intensity ranking.

Through this fresh lens, many European and United States clusters show more intense S&T activity than their Asian counterparts (see Map 3 and Table 9). The United States has seven clusters in the top 25 by S&T intensity, followed by Germany with five, and Switzerland and Sweden with three each.

Map 3 European S&T clusters by intensity



Source: WIPO Statistics Database, April 2022.

Table 9 Top S&T clusters by S&T intensity, 2022

Rank per capita	Cluster name	Economy
1	Cambridge	GB
2	Eindhoven	NL/BE
3	Daejeon	KR
4	San Jose–San Francisco, CA	US
5	Oxford	GB
6	Boston–Cambridge, MA	US
7	Ann Arbor, MI	US
8	San Diego, CA	US
9	Seattle, WA	US
10	Lund–Malmö	SE
11	Lausanne	CH/FR
12	Raleigh, NC	US
13	Munich	DE
14	Kanazawa	JP
15	Stockholm	SE
16	Göteborg	SE
17	Helsinki	FI
18	Nuremberg–Erlangen	DE
19	Zürich	CH/DE
20	Tokyo–Yokohama	JP
21	Copenhagen	DK
22	Beijing	CN
23	Stuttgart	DE
24	Basel	CH/DE/FR
25	Portland, OR	US

Source: WIPO Statistics Database, April 2022.

As was the case in the previous year's GII S&T cluster ranking, S&T intensity was higher in those cases where patenting activity drove a cluster's output, with 20 out of the top 25 clusters deriving the majority of their output from patents.

As expected, China, in particular, scores less well when correcting for population. Applying this methodology, Beijing (23) makes it into the top 25 by S&T intensity but no other Chinese or middle-income economy cluster does. Relative to the top S&T cluster ranking, Brazil, India, Iran, the Russian Federation and Türkiye maintain the same number of clusters in this top 100 S&T intensity ranking: Tehran (77) in Iran; Ankara (91) and Istanbul (95) in Türkiye; Moscow (94) in the Russian Federation; Bengaluru (96), Chennai (97), Delhi (99) and Mumbai (100) in India; and São Paulo (98) in Brazil (in order of best ranked cluster, with Tehran ranking highest).

Note

1 S&T output growth refers to the net S&T output over time, which is the difference in total patents and publications for each cluster, for all points that were located inside the same cluster compared to the previous year.

Appendix IV
Global Innovation Index science and technology cluster methodology

Since 2016, the Global Innovation Index (GII) has sought to identify science and technology (S&T) clusters using a bottom-up approach. This approach disregards administrative or political borders and instead pinpoints those geographical areas that show a high density of inventors and scientific authors. The resultant clusters often encompass several municipal districts, sub-federal states and sometimes even two or more countries. Two innovation metrics are employed in the compilation of the top 100 GII S&T clusters worldwide: location of inventors listed on published patent applications and authors listed on published scientific articles.

For patents, this method relies on applications under WIPO's Patent Cooperation Treaty (PCT). PCT patents offer a useful basis for analyzing patents globally. The PCT system applies a single set of procedural rules and collects information based on uniform filing standards. This reduces potential biases that could arise from using data collected from multiple national sources. The patents selected were published over a five-year period, between 2016 and 2020, to minimize the effects of volatility that can occur between years.

To widen the range of innovation included, scientific publications from the Web of Science's Science Citation Index Expanded (SCIE) are incorporated. SCIE provides detailed coverage of the world's most impactful academic journals. For the analysis presented here, science and technology fields are the focus, while articles from the fields of social sciences and humanities are disregarded. The same publication years are used for scientific articles as are used for PCT patents – 2016 to 2020.

In addition, for this year's analysis, in a departure from previous years' practice, scientific publications are limited solely to articles of original research. This excludes other published items, such as meeting abstracts, conference summaries or paper briefs, which were previously included in the analysis. Although these items were published in journals, Web of Science does not deem them to be full articles. In addition, meeting abstracts and paper briefs are not utilized equally across all academic fields. As a result, the life sciences academic fields, in which meeting abstracts are primarily published, have had their shares of total publications in the SCIE reduced. The knock-on effect of this change is that the total publication output of any cluster with a high concentration of life sciences activity has been reduced. In the GII 2022, previous years' rankings were adjusted to account for this change in methodology and to allow accurate year-on-year comparisons to be made.

The WIPO PCT patent dataset consists of approximately 1.1 million patent applications published between 2016 and 2020, containing 3.4 million inventor addresses. For the SCIE, the dataset contains 7.1 million articles published during the same period, containing 22.4 million listed author addresses.

The geocoding of addresses for this report is as follows. PCT inventor addresses were geocoded using the Environmental Systems Research Institute (ESRI) ArcGIS World Geocoder service.[1] In cases where the ESRI address matches proved either ambiguous or insufficiently accurate, the city name in the address string was extracted and matched using records in the city-level dataset from the GeoNames Gazetteer database.[2] This latter database gives the geolocation of cities around the globe and contains 48,000 geocoded cities. This same city-matching approach was applied to all SCIE author addresses.

Overall, 96.4 percent of inventor addresses were geocoded at either the city level or a more accurate level, while 95.9 percent of scientific author addresses were geocoded at the city level. Appendix Table 5 provides a summary of the geocoding results for the top 20 countries, which together account for the majority of inventor and scientific author addresses. As shown in the table, the coverage of geocoded addresses across all 20 countries is typically above 95 percent, only falling below 90 percent in two instances.

Addresses were clustered by applying the density-based spatial clustering of applications with noise (DBSCAN) algorithm. This algorithm requires predefined radius and density parameters. As in previous years, a radius of 15 km and a density of 4,500 listed inventors/authors was applied. Equal weight was given to inventors and authors by expressing data points as a share of total inventor and author addresses, respectively. Given that the number of scientific articles far exceeds the number of patents, cluster identification based on the raw data points would have resulted in clusters shaped predominantly by the scientific author landscape.

The result was an initial list of 233 clusters. After review, neighboring clusters were merged if the edge of one cluster was within 3–5 km of another and where the co-author/co-inventor relationships were higher than for any other relationship with any other cluster or non-cluster points. A total of 20 clusters met these criteria, with mergers reducing the overall number of clusters identified to 223.[3]

The remaining 223 clusters were then ranked by counting the number of patents and scientific articles in a given cluster. Numbers were aggregated using fractional counting, in which counts reflect the share of a patent's inventors and an article's authors present in a particular cluster. In addition, mirroring the equal weighting approach described above, fractional counts are relative to the total numbers of patents and scientific articles.

To produce an intensity ranking, the European Commission's Global Human Settlement Layer (GHSL) population distribution data were matched geographically to the top 100 clusters identified in the overall ranking. Just as with inventor/author geocoded locations, these population data allowed us to define the total population of a cluster using a bottom-up approach. We chose to define a cluster's area as all the space within 0.05 degrees of each inventor/author location. Overlaying the resultant cluster polygons on top of the population data and aggregating all points which lay within each polygon gave a total population estimate for each cluster.[4] The clusters were then ranked by dividing the total S&T share by population.

Appendix Table 3 Top 100 S&T clusters, 2022

Cluster rank	Cluster name	Economy	PCT applications	Scientific publications	Share total PCT filings (%)	Share of total publications (%)	Total	Rank 2015–19[a]	Rank change[a]
1	Tokyo–Yokohama	JP	122,526	112,890	10.7	1.6	12.3	1	0
2	Shenzhen–Hong Kong–Guangzhou	CN/HK	94,340	133,327	8.2	1.9	10.1	2	0
3	Beijing	CN	32,016	260,937	2.8	3.7	6.5	3	0
4	Seoul	KR	46,273	124,530	4.0	1.8	5.8	4	0
5	San Jose–San Francisco, CA	US	42,884	58,087	3.7	0.8	4.6	5	0
6	Shanghai–Suzhou	CN	22,869	148,203	2.0	2.1	4.1	7	1
7	Osaka–Kobe–Kyoto	JP	34,738	50,605	3.0	0.7	3.8	6	−1
8	Boston–Cambridge, MA	US	16,172	73,457	1.4	1.0	2.4	8	0
9	New York City, NY	US	13,020	73,623	1.1	1.0	2.2	9	0
10	Paris	FR	14,147	62,793	1.2	0.9	2.1	10	0
11	San Diego, CA	US	19,363	20,688	1.7	0.3	2.0	11	0
12	Nagoya	JP	18,623	17,261	1.6	0.2	1.9	12	0
13	Nanjing	CN	3,620	103,260	0.3	1.5	1.8	15	2
14	Hangzhou	CN	8,568	55,312	0.7	0.8	1.5	18	4
15	Los Angeles, CA	US	10,515	43,172	0.9	0.6	1.5	14	−1
16	Wuhan	CN	4,126	80,002	0.4	1.1	1.5	20	4
17	Washington, DC–Baltimore, MD	US	4,727	75,104	0.4	1.1	1.5	13	−4
18	Seattle, WA	US	11,943	20,396	1.0	0.3	1.3	16	−2
19	London	GB	4,936	56,911	0.4	0.8	1.2	19	0
20	Daejeon	KR	10,286	23,812	0.9	0.3	1.2	22	2
21	Houston, TX	US	9,785	24,529	0.9	0.3	1.2	17	−4
22	Xi'an	CN	1,114	76,727	0.1	1.1	1.2	25	3
23	Cologne	DE	7,829	33,454	0.7	0.5	1.2	21	−2
24	Munich	DE	9,166	24,018	0.8	0.3	1.1	24	0
25	Amsterdam–Rotterdam	NL	4,304	52,561	0.4	0.7	1.1	23	−2
26	Taipei–Hsinchu	TW	3,439	51,666	0.3	0.7	1.0	26	0
27	Chicago, IL	US	6,433	32,183	0.6	0.5	1.0	29	2
28	Stuttgart	DE	9,086	14,604	0.8	0.2	1.0	27	−1
29	Chengdu	CN	1,701	58,696	0.1	0.8	1.0	33	4
30	Tel Aviv–Jerusalem	IL	7,238	23,378	0.6	0.3	1.0	28	−2
31	Moscow	RU	1,927	53,109	0.2	0.7	0.9	30	−1
32	Tehran	IR	273	61,807	0.0	0.9	0.9	32	0
33	Singapore	SG	4,370	35,483	0.4	0.5	0.9	31	−2
34	Qingdao	CN	4,010	33,745	0.3	0.5	0.8	46	12
35	Stockholm	SE	5,978	20,040	0.5	0.3	0.8	35	0
36	Eindhoven	BE/NL	8,162	5,245	0.7	0.1	0.8	34	−2
37	Tianjin	CN	1,018	48,619	0.1	0.7	0.8	39	2
38	Minneapolis, MN	US	6,382	15,438	0.6	0.2	0.8	36	−2
39	Melbourne	AU	2,071	39,314	0.2	0.6	0.7	37	−2
40	Berlin	DE	3,518	30,355	0.3	0.4	0.7	44	4
41	Changsha	CN	831	46,712	0.1	0.7	0.7	51	10
42	Frankfurt am Main	DE	5,234	18,355	0.5	0.3	0.7	38	−4
43	Sydney	AU	2,586	33,203	0.2	0.5	0.7	40	−3
44	Philadelphia, PA	US	3,437	27,592	0.3	0.4	0.7	41	−3
45	Raleigh, NC	US	2,888	30,006	0.3	0.4	0.7	42	−3
46	Istanbul	TR	3,419	25,640	0.3	0.4	0.7	50	4
47	Brussels	BE	3,094	27,429	0.3	0.4	0.7	43	−4
48	Madrid	ES	1,498	37,284	0.1	0.5	0.7	47	−1
49	Chongqing	CN	1,390	36,776	0.1	0.5	0.6	58	9
50	Barcelona	ES	2,468	29,692	0.2	0.4	0.6	48	−2

Appendix Table 3 Continued

Cluster rank	Cluster name	Economy	PCT applications	Scientific publications	Share total PCT filings (%)	Share of total publications (%)	Total	Rank 2015–19[a]	Rank change[a]
51	Zürich	CH/DE	3,406	23,856	0.3	0.3	0.6	52	1
52	Portland, OR	US	6,151	6,766	0.5	0.1	0.6	45	−7
53	Milan	IT	2,391	29,681	0.2	0.4	0.6	53	0
54	Toronto, ON	CA	2,438	29,042	0.2	0.4	0.6	49	−5
55	Hefei	CN	1,016	35,125	0.1	0.5	0.6	63	8
56	Harbin	CN	178	39,628	0.0	0.6	0.6	61	5
57	Montréal, QC	CA	2,129	25,461	0.2	0.4	0.5	54	−3
58	Heidelberg–Mannheim	DE	3,908	13,951	0.3	0.2	0.5	56	−2
59	Copenhagen	DK	3,075	18,889	0.3	0.3	0.5	55	−4
60	Bengaluru	IN	3,746	14,604	0.3	0.2	0.5	60	0
61	Jinan	CN	973	31,115	0.1	0.4	0.5	67	6
62	Cambridge	GB	3,052	17,711	0.3	0.2	0.5	62	0
63	Changchun	CN	305	34,500	0.0	0.5	0.5	70	7
64	Delhi	IN	1,046	28,440	0.1	0.4	0.5	66	2
65	Denver, CO	US	2,449	18,478	0.2	0.3	0.5	57	−8
66	Atlanta, GA	US	1,660	23,326	0.1	0.3	0.5	64	−2
67	Rome	IT	846	28,301	0.1	0.4	0.5	68	1
68	Shenyang	CN	608	29,090	0.1	0.4	0.5	77	9
69	Cincinnati, OH	US	3,913	7,811	0.3	0.1	0.5	65	−4
70	Nuremberg–Erlangen	DE	3,649	9,390	0.3	0.1	0.5	69	−1
71	São Paulo	BR	757	25,887	0.1	0.4	0.4	71	0
72	Dalian	CN	861	24,692	0.1	0.3	0.4	81	9
73	Helsinki	FI	2,672	13,346	0.2	0.2	0.4	72	−1
74	Busan	KR	2,273	15,584	0.2	0.2	0.4	74	0
75	Dallas, TX	US	3,191	9,826	0.3	0.1	0.4	73	−2
76	Vienna	AT	1,560	19,473	0.1	0.3	0.4	75	−1
77	Ann Arbor, MI	US	1,293	19,803	0.1	0.3	0.4	76	−1
78	Oxford	GB	1,551	18,051	0.1	0.3	0.4	79	1
79	Pittsburgh, PA	US	1,696	17,077	0.1	0.2	0.4	78	−1
80	Kanazawa	JP	3,814	3,384	0.3	0.0	0.4	84	4
81	Lyon	FR	2,381	12,029	0.2	0.2	0.4	80	−1
82	Vancouver, BC	CA	1,482	16,126	0.1	0.2	0.4	82	0
83	Zhengzhou	CN	631	21,129	0.1	0.3	0.4	98	15
84	Mumbai	IN	1,481	15,671	0.1	0.2	0.4	87	3
85	Hamamatsu	JP	3,548	2,650	0.3	0.0	0.3	83	−2
86	Ankara	TR	566	20,198	0.0	0.3	0.3	89	3
87	Ottawa, ON	CA	1,928	11,782	0.2	0.2	0.3	86	−1
88	Daegu	KR	1,843	12,268	0.2	0.2	0.3	91	3
89	Phoenix, AZ	US	2,358	8,842	0.2	0.1	0.3	85	−4
90	Austin, TX	US	2,156	9,993	0.2	0.1	0.3	88	−2
91	Xiamen	CN	1,387	14,650	0.1	0.2	0.3	103	12
92	Warsaw	PL	449	20,399	0.0	0.3	0.3	92	0
93	Lausanne	CH/FR	1,872	10,928	0.2	0.2	0.3	90	−3
94	Brisbane	AU	1,184	15,158	0.1	0.2	0.3	96	2
95	Hamburg	DE	1,840	11,049	0.2	0.2	0.3	94	−1
96	Lund–Malmö	SE	2,148	9,126	0.2	0.1	0.3	95	−1
97	Chennai	IN	686	18,094	0.1	0.3	0.3	99	2
98	Göteborg	SE	1,990	9,971	0.2	0.1	0.3	97	−1
99	Basel	CH/DE/FR	2,294	7,835	0.2	0.1	0.3	106	7
100	Lanzhou	CN	200	20,669	0.0	0.3	0.3	110	10

Source: WIPO Statistics Database, April 2022.

Notes: [a] This column represents the previous year's rankings, which have been adjusted to align with the updated methodology.

The codes given in the tables in this appendix are the ISO alpha-2 country codes, with the following addition: TW = Taiwan Province of China.

Appendix Table 4 Ranking of S&T intensity, 2016–2020

Intensity rank	Cluster name	Economy	Estimated cluster population	PCT applications per capita[a]	Scientific publications per capita[a]	Total S&T share per capita[a]	Rank change[b]
1	Cambridge	GB	470,565	6,486	37,637	1.10	0.0
2	Eindhoven	BE/NL	1,004,435	8,126	5,222	0.78	0.0
3	Daejeon	KR	1,639,385	6,274	14,525	0.75	2.0
4	San Jose–San Francisco, CA	US	6,075,112	7,059	9,561	0.75	0.0
5	Oxford	GB	530,708	2,922	34,013	0.73	−2.0
6	Boston–Cambridge, MA	US	3,735,101	4,330	19,667	0.65	1.0
7	Ann Arbor, MI	US	633,653	2,041	31,252	0.62	−1.0
8	San Diego, CA	US	3,485,292	5,556	5,936	0.57	1.0
9	Seattle, WA	US	2,345,646	5,092	8,695	0.57	−1.0
10	Lund–Malmö	SE	596,694	3,601	15,295	0.53	0.0
11	Lausanne	CH/FR	683,652	2,738	15,985	0.46	1.0
12	Raleigh, NC	US	1,509,942	1,912	19,872	0.45	1.0
13	Munich	DE	2,564,434	3,574	9,366	0.44	2.0
14	Kanazawa	JP	858,746	4,441	3,941	0.44	2.0
15	Stockholm	SE	1,930,446	3,097	10,381	0.42	−1.0
16	Göteborg	SE	781,241	2,547	12,763	0.40	1.0
17	Helsinki	FI	1,196,571	2,233	11,154	0.35	1.0
18	Nuremberg–Erlangen	DE	1,311,956	2,781	7,157	0.34	1.0
19	Zürich	CH/DE	1,845,731	1,846	12,925	0.34	3.0
20	Tokyo–Yokohama	JP	36,101,573	3,394	3,127	0.34	1.0
21	Copenhagen	DK	1,579,632	1,947	11,958	0.34	−1.0
22	Beijing	CN	19,701,843	1,625	13,244	0.33	4.0
23	Stuttgart	DE	3,076,928	2,953	4,746	0.32	0.0
24	Basel	CH/DE/FR	983,777	2,332	7,964	0.32	n.a.
25	Portland, OR	US	2,066,968	2,976	3,273	0.31	−1.0
26	Minneapolis, MN	US	2,544,571	2,508	6,067	0.30	−1.0
27	Hamamatsu	JP	1,234,076	2,875	2,148	0.28	0.0
28	Pittsburgh, PA	US	1,393,500	1,217	12,255	0.28	1.0
29	Heidelberg–Mannheim	DE	1,934,306	2,020	7,213	0.28	1.0
30	Ottawa, ON	CA	1,211,901	1,591	9,722	0.28	−2.0
31	Seoul	KR	22,072,971	2,096	5,642	0.26	1.0
32	Cincinnati, OH	US	1,792,686	2,183	4,357	0.25	−1.0
33	Nanjing	CN	7,387,581	490	13,977	0.24	6.0
34	Washington, DC–Baltimore, MD	US	6,163,260	767	12,186	0.24	0.0
35	Houston, TX	US	5,201,592	1,881	4,716	0.23	−2.0
36	Osaka–Kobe–Kyoto	JP	16,311,764	2,130	3,102	0.23	1.0
37	Austin, TX	US	1,494,842	1,442	6,685	0.22	−2.0
38	Nagoya	JP	8,646,445	2,154	1,996	0.22	−2.0
39	Shenzhen–Hong Kong–Guangzhou	CN/HK	48,232,020	1,956	2,764	0.21	7.0
40	Hangzhou	CN	7,404,928	1,157	7,470	0.21	9.0
41	Lyon	FR	1,851,523	1,286	6,497	0.20	−3.0
42	Sydney	AU	3,479,638	743	9,542	0.20	−1.0
43	Frankfurt am Main	DE	3,667,871	1,427	5,004	0.19	−3.0
44	Xi'an	CN	6,062,141	184	12,657	0.19	10.0
45	Vancouver, BC	CA	1,859,081	797	8,674	0.19	−2.0
46	Paris	FR	11,065,479	1,278	5,675	0.19	−4.0
47	Melbourne	AU	3,869,266	535	10,161	0.19	0.0
48	Atlanta, GA	US	2,494,571	665	9,351	0.19	−3.0
49	Changsha	CN	3,877,621	214	12,047	0.19	9.0
50	Qingdao	CN	4,384,550	915	7,696	0.19	10.0

Appendix Table 4 Continued

Intensity rank	Cluster name	Economy	Estimated cluster population	PCT applications per capita[a]	Scientific publications per capita[a]	Total S&T share per capita[a]	Rank change[b]
51	Berlin	DE	3,986,888	883	7,614	0.18	0.0
52	Vienna	AT	2,232,293	699	8,723	0.18	−4.0
53	Wuhan	CN	8,200,368	503	9,756	0.18	8.0
54	Denver, CO	US	2,697,025	908	6,851	0.18	−10.0
55	Amsterdam–Rotterdam	NL	6,706,354	642	7,837	0.17	−3.0
56	Philadelphia, PA	US	4,158,492	827	6,635	0.17	−3.0
57	Brisbane	AU	1,921,593	616	7,888	0.16	−2.0
58	Brussels	BE	4,012,868	771	6,835	0.16	−2.0
59	Montréal, QC	CA	3,438,561	619	7,405	0.16	−2.0
60	Tel Aviv–Jerusalem	IL	6,194,937	1,168	3,774	0.16	−1.0
61	Chicago, IL	US	6,669,347	965	4,826	0.15	−11.0
62	Changchun	CN	3,449,825	89	10,001	0.15	7.0
63	Milan	IT	4,272,035	560	6,948	0.15	7.0
64	Rome	IT	3,225,175	262	8,775	0.15	0.0
65	Barcelona	ES	4,372,762	564	6,790	0.14	−3.0
66	Toronto, ON	CA	4,385,891	556	6,622	0.14	−3.0
67	New York City, NY	US	15,376,438	847	4,788	0.14	−2.0
68	Jinan	CN	3,795,644	256	8,198	0.14	5.0
69	Harbin	CN	4,213,667	42	9,405	0.14	10.0
70	Hefei	CN	4,310,124	236	8,149	0.14	10.0
71	London	GB	9,121,643	541	6,239	0.14	−4.0
72	Warsaw	PL	2,441,181	184	8,356	0.13	−4.0
73	Hamburg	DE	2,369,780	776	4,663	0.13	−7.0
74	Daegu	KR	2,515,209	733	4,878	0.13	−2.0
75	Lanzhou	CN	2,402,088	83	8,605	0.13	n.a.
76	Los Angeles, CA	US	11,919,383	882	3,622	0.13	−1.0
77	Tehran	IR	7,000,893	39	8,828	0.13	0.0
78	Dalian	CN	3,334,357	258	7,405	0.13	6.0
79	Cologne	DE	9,091,259	861	3,680	0.13	−8.0
80	Shanghai–Suzhou	CN	32,327,159	707	4,584	0.13	−2.0
81	Singapore	SG	7,033,274	621	5,045	0.13	−5.0
82	Phoenix, AZ	US	2,707,043	871	3,266	0.12	−8.0
83	Madrid	ES	5,564,353	269	6,700	0.12	−1.0
84	Busan	KR	3,546,354	641	4,394	0.12	−3.0
85	Chongqing	CN	5,656,871	246	6,501	0.11	0.0
86	Dallas, TX	US	3,705,446	861	2,652	0.11	−3.0
87	Chengdu	CN	9,522,089	179	6,164	0.10	1.0
88	Tianjin	CN	7,863,787	129	6,183	0.10	−1.0
89	Taipei–Hsinchu	TW	10,721,652	321	4,819	0.10	−3.0
90	Shenyang	CN	5,480,076	111	5,308	0.08	0.0
91	Ankara	TR	4,517,811	125	4,471	0.07	−2.0
92	Zhengzhou	CN	4,804,781	131	4,398	0.07	0.0
93	Xiamen	CN	4,638,988	299	3,158	0.07	n.a.
94	Moscow	RU	13,373,449	144	3,971	0.07	−3.0
95	Istanbul	TR	14,635,274	234	1,752	0.05	−1.0
96	Bengaluru	IN	12,335,706	304	1,184	0.04	−3.0
97	Chennai	IN	9,987,867	69	1,812	0.03	−2.0
98	São Paulo	BR	18,630,251	41	1,390	0.02	−2.0
99	Delhi	IN	24,557,885	43	1,158	0.02	−2.0
100	Mumbai	IN	19,881,600	74	788	0.02	−2.0

Source: WIPO Statistics Database, April 2022.

Notes: [a] Per capita figures refer to 1,000,000 of population. [b] The previous year's rankings have been adjusted to align with the updated methodology. Codes refer to the ISO alpha-2 country codes, with the following addition: TW = Taiwan Province of China.

Appendix Table 5 Summary of geocoding results

	Scientific publications			PCT applications				
Country	Number of addresses	City-level address accuracy (%)	Publications covered (%)	Number of addresses	Block-level address accuracy (%)	Sub-city-level address accuracy (%)	City-level address accuracy (%)	Applications covered (%)
China	4,836,417	99.0	99.5	643,189	89.0	0.1	10.9	99.9
United States	6,601,955	97.0	98.2	888,439	94.6	5.1	0.1	99.9
Japan	1,225,196	92.3	95.6	593,670	31.5	26.3	40.6	98.8
Germany	1,415,642	97.7	98.5	269,492	97.5	0.5	1.9	99.9
Republic of Korea	809,478	96.3	98.0	252,035	0.1	0.9	79.7	86.9
United Kingdom	1,437,049	96.8	97.9	83,678	64.0	27.6	8.0	99.6
France	1,103,856	93.4	95.5	108,437	90.4	1.9	5.4	98.1
India	786,896	91.9	94.4	42,840	33.0	52.1	13.9	99.2
Italy	1,164,449	95.8	97.3	43,602	91.0	5.2	3.4	99.6
Canada	915,638	98.4	99.0	43,920	96.9	2.6	0.4	99.8
Spain	882,748	97.6	98.6	26,809	80.5	11.7	7.6	99.8
Brazil	684,488	98.5	99.6	9,883	85.5	10.8	3.5	99.7
Australia	878,644	86.1	90.3	21,259	91.7	5.0	2.9	99.7
Netherlands	522,047	97.4	98.6	51,052	85.2	0.3	14.4	99.8
Sweden	306,161	98.0	98.4	44,888	94.7	0.8	4.4	99.9
Russian Federation	400,543	99.0	99.3	14746	90.8	5.0	3.6	99.6
Iran (Islamic Republic of)	456,057	97.3	98.5	1,083	0.2	2.3	93.5	95.5
Türkiye	396,686	96.4	96.7	16,593	45.1	41.8	11.1	98.4
Switzerland	343,054	90.8	92.5	38,982	91.8	1.3	6.8	99.8
Poland	316,725	98.7	99.4	6,477	94.4	4.5	0.9	99.7

Source: WIPO Statistics Database, April 2022.

Notes: This list includes the top 20 countries that account for the highest combined shares of patents and scientific articles. PCT inventor addresses were geocoded to the highest level of detail. Due to their much larger volume, scientific author addresses were geocoded to the city level only.

Notes

1 ESRI World Geocoder service. https://www.esri.com/en-us/arcgis/products/arcgis-world-geocoder.

2 GeoNames. http://geonames.org/.

3 The mergers involved the following clusters: Guangzhou with Shenzhen–Hong Kong; Matsudo with Tokyo–Yokohama; Jerusalem with Tel Aviv; Istanbul Europe with Istanbul Asia; Rotterdam with Amsterdam; Irvine with Los Angeles; Boulder with Denver; Baltimore with Washington DC; Suzhou with Shanghai; Aurora with Chicago.

4 See Bergquist and Fink (2020: 61–63) for a more detailed description of how population data were matched to clusters: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020.pdf.

Reference

Bergquist, K. and C. Fink (2020). The top 100 science and technology clusters. In Dutta, S., B. Lanvin and S. Wunsch-Vincent (eds), *The Global Innovation Index 2020: Who Will Finance Innovation?* Ithaca, NY, Fontainebleau and Geneva: Cornell University, INSEAD and WIPO.