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A bibliometric analysis of research on Central Asia during 1990–2014

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Abstract A bibliometric analysis was performed in this work to evaluate the research publications on Central Asia from 1990 to 2014 based on Science Citation Index and Social Science Citation Index databases. This study presented a comprehensive overview of the field from the aspects of major journals, subject categories, outstanding keywords, leading countries, institutions and authors, as well as the research collaborations. It was identified that a total of 11,025 papers were published in 2356 journals and there had been a steady development over the past 25 years for Central Asia research. Geosciences Multidisciplinary, Geochemistry and Geophysics, Paleontology, Environmental Sciences and Zoology were the most popular subject categories. Keywords analysis indicated that "Tien Shan", "climate change", "taxonomy", "new taxa", and "health care" were the topics that generated the most interest and concern. Besides, temporal evolution of keywords revealed the rapid growth of "Central Asia Orogenic Belt" and "Zircon UPb dating". According to research forces analysis, USA and Russian Academy of Sciences came as the leading contributors and had the dominant position in collaboration networks. This paper was a new attempt to better the understanding of the progress in Central Asia research. The findings of this study would help researchers improve the performance.

Keywords Bibliometric analysis · Scientific outputs · Central Asia · Keywords analysis · Collaboration network

Introduction

Central Asia is the core region of the Asian continent and is also sometimes referred to as Middle Asia. Various definitions of its exact composition exist, and not one definition is universally accepted. In this paper, Central Asia refers to the countries of Central Asia

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region, taken as the five "Stans" of the former Soviet Union: Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan, and Turkmenistan.

Central Asia boasts an abundance of underground resources of petroleum and natural gas, gold and uranium ore, among others, and it is home to an intricate web of concerns and interest from various sources of influence (Aso 2006). Research on Central Asia has been performed all over the world, and a large number of papers are published in various journals, with the content involving geopolitics (Sharshenova 2014; Zabyelina 2013), economic transition (Rosenbaurn et al. 2012; Djalilov and Piesse 2011), regional development (Kangas 2014; Wang 2014), natural resources (Dorian 2006; Beer et al. 2008; Jalilov et al. 2013), ecological environment (Feng 2013; Schluter and Herrfahrdt-Pahle 2011), etc. However, few efforts have been made to gather systematic data on the global scientific outputs on Central Asia.

Bibliometrics is a set of methods to quantitatively analyse scientific and technological literature (Bellis 2009). Citation analysis and content analysis are commonly used bibliometric methods, and they are now widely used in quantitative research assessment in many fields (Ho 2014; Mallik and Mandal 2014; Zhang et al. 2014; Ji et al. 2014; Alvarez-Betancourt and Garcia-Silvente 2014).

Based on SCIE and SSCI databases and using bibliometric methods, the study analyzes on Central Asia research as reflected by its publications during 1990–2014. The aim was to reveal underlying patterns in scientific outputs, pinpoint subject-specific research, target high-impact countries, institutions and authors, and identify qualified collaborations.

Data and methods

We built our bibliometric database on 5 January, 2015 based on ISI Web of Science. The search strategy used to retrieve the data on Central Asia was as follows:

TS = ("Central Asia" or "Middle Asia" or Kazakhstan or (Kyrgyz Republic) or Kyrgyzstan or Kirgizstan or Tajikistan or Tadzhikistan or Tajikstan or Uzbekistan or Turkmenistan or Alma-Ata or Almaty or Astana or Aqmola or Ashgabat or Bishkek or Dushanbe or Tashkent or "Aral sea" or Amu$darya or Syr$darya or Issyk$Kul or Balkhash or (Naryn River) or (Chu River) or (Talas River) or (Lake Alakol) or (Zeravshan River) or (Kara Darya) or (Vakhsh River) or (Rogun Dam) or (Nurek Dam) or (Toktogul Dam) or (Kapchagay Dam) or (Alai Range) or (Fergana Valley) or (Karakum Desert) or (Kyzyl Kum) or (Severnaya Golodnaya Steppe) or (Betpak-Dala) or Samarkand or (Turan Depression)) and py = 1990–2014. Document type = article, proceeding paper and review. Databases = SCI-Expanded, SSCI.

Using the above search strategy, 11,025 publications were identified (data in 2014 may be incomplete as the databases lag). When analyzing the research topics, author keywords were retrieved directly as they appeared in each paper. Different words with identical meanings were grouped and considered as a single keyword. Additionally, papers originating from England, Scotland, North Ireland, and Wales were reclassified as being from the United Kingdom (the UK), while papers from Hong Kong and Taiwan were not included in China. Finally, Thomson Data Analyzer (TDA), Microsoft Excel and UCINET (UCINET 6 for Windows) were used to do data mining, figure preparation and data visualization respectively.

Results and discussion

Temporal evolution

There had been a stable development over the past 25 years for Central Asia research, and the annual number of papers increased from 81 in 1990 to 933 in 2014. The document type was dominated by articles, which accounted for 89.4 % of all the publications. The number of articles increased steadily during 1990–2004, and a remarkable growth was observed from 2005 to 2014. A less-significant portion was comprised of proceeding papers (5.8 %) and reviews (4.8 %), which did not catch too much attention during the whole study period. Overall, the total number of papers for 2005–2014 reached 1.8 times of that for 1990–2004. The growing trend obtained in Fig. 1 indicated that increased attention had been paid to Central Asia research.

Leading journals

Research papers on Central Asia appeared in 2356 journals. The top 10 most productive journals published 1172 (10.63 %) of the total 11,025 papers and received 14,068 (15.39 %) of the total 91,420 citations. As shown in Table 1, Zoologichesky Zhurnal ranked first with 276 papers, approximately doubled the number of second-placed Acta Petrologica Sinica. However, the average citation (1.27) and impact factor (IF) (0.194) for Zoologichesky Zhurnal were both unsatisfactory among the top 10 journals. In contrast, Earth and Planetary Science Letters published only 91 papers, but earned the highest TC/TP of 42.45 and top IF of 4.724, which revealed the significant influence of the journal in Central Asia research.

Web of Science categories

Based on Web of Science categories, Central Asia research covered 214 scientific categories during 1990–2014. The top 10 most productive categories were Geosciences, Multidisciplinary (1579, 14.32 %), Geochemistry and Geophysics (1020, 9.25 %), Paleontology (659, 5.98 %), Environmental Sciences (653, 5.92 %), Zoology (614, 5.57 %), Geology (480, 4.35 %), Plant Sciences (472, 4.28 %), Geography, Physical (456, 4.14 %),

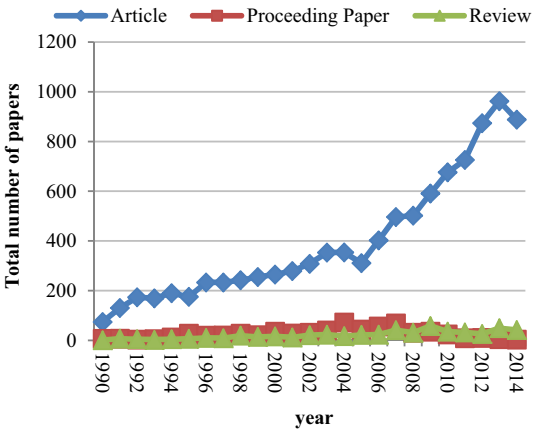

Fig. 1 Temporal evolution of the number of publications

Table 1 Top ten journals based on total number of papers

Journal	TP	TC	TC/TP	IF 2013	Country
Zoologichesky Zhurnal	276	350	1.27	0.194	Russia
Acta Petrologica Sinica	126	1510	11.98	1.224	China
Zootaxa	109	170	1.56	1.060	New Zealand
Paleontological Journal	102	259	2.54	0.579	Russia
Tectonophysics	98	3817	38.95	2.866	Netherland
Russian Geology and Geophysics	97	640	6.60	1.409	Russia
Journal of Asian Earth Sciences	95	2378	25.03	2.831	UK
Earth and Planetary Science Letters	91	3863	42.45	4.724	Netherland
Plos One	91	1054	11.58	3.534	USA
Osteuropa[a]	87	27	0.31		Germany

TP total number of publications, *TC* total number of citations, *TC/TP* average number of citations per paper, IF 2013: journal citation report impact factor (JCR year 2013)

[a] without impact factor

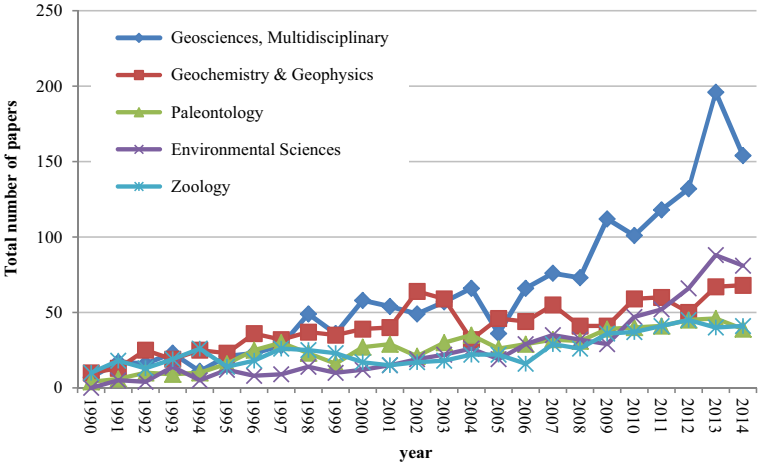

Fig. 2 Year wise growth of the top five most productive web of science categories

Political Science (433, 3.93 %) and Economics (391, 3.55 %). Papers in these ten categories amounted to 6590, accounting for 60 % of the total number.

Concerning the annual development for the top five categories during 1990–2014, Geosciences, Multidisciplinary held primacy and had more obviously increasing trajectory than others (Fig. 2). Geochemistry and Geophysics had the similar tendency with Geosciences, Multidisciplinary in the initial stage, but lagged behind since 2004, with the gap widening ever since. Paleontology, Environmental Sciences and Zoology shifted their ranks frequently, and there was no obvious increasing tendency in these three categories.

Outstanding research topics

Keywords provided important information about research trends and frontiers, revealing areas of research interest (Ji et al. 2014). The 11,025 papers in our database contained

34,998 occurrences of 16,387 unique author keywords, however, 12,789 (78.04 %) keywords appeared just once, 1761 (10.75 %) keywords were used twice, and 15,568 (95 %) keywords appeared in >5 papers.

The top 30 most frequently used keywords were summarized in Table 2. Every keyword involved was counted and ranked within each of the 5-year intervals during 1990–2014. Meanwhile, we created a cross-correlation matrix based on the top 30 keywords, and then imported the matrix into UCINET to perform visualization (Fig. 3).

The limitation of study area is very common in keywords, which is the characteristic for regional issues research. Apart from our search terms "Central Asia", "Kazakhstan",

Table 2 Top 30 most frequently used author keywords during 1990–2014: in 5-year intervals

	Keywords	TP	1990–1994 *R* (%)	1995–1999 *R* (%)	2000–2004 *R* (%)	2005–2009 *R* (%)	2010–2014 *R* (%)
1	Central Asia	719	1 (2.19)	1 (3.30)	1 (2.90)	1 (3.66)	1 (3.83)
2	Kazakhstan	500	2 (1.46)	2 (2.88)	2 (2.38)	2 (2.26)	2 (2.60)
3	Tien Shan↑	261	18 (0.37)	14 (0.59)	3 (1.25)	4 (1.31)	4 (1.47)
4	Climate change↑	246		14 (0.59)	6 (0.85)	8 (1.06)	3 (1.61)
5	Taxonomy	218	2 (1.46)	4 (0.94)	8 (0.76)	3 (1.36)	8 (1.02)
6	Kyrgyzstan	204	56 (0.18)	28 (0.41)	5 (0.89)	6 (1.16)	5 (1.12)
7	Uzbekistan	203	11 (0.55)	4 (0.94)	7 (0.82)	7 (1.14)	8 (1.02)
8	China	201	56 (0.18)	8 (0.77)	8 (0.76)	5 (1.21)	7 (1.03)
9	New taxa	188	4 (1.28)	3 (1.59)	16 (0.55)	9 (1.05)	11 (0.85)
10	Health care	151	56 (0.18)	25 (0.47)	47 (0.31)	17 (0.62)	6 (1.05)
11	Zircon UPb dating↑	147		123 (0.12)	36 (0.37)	11 (0.77)	10 (0.98)
12	Tajikistan	143	5 (1.10)	22 (0.53)	25 (0.46)	14 (0.71)	12 (0.80)
13	Aral sea	127	7 (0.91)	22 (0.53)	4 (1.16)	12 (0.75)	36 (0.37)
14	Phylogenetics	124	56 (0.18)	11 (0.65)	16 (0.55)	12 (0.75)	16 (0.57)
15	Mongolia	117	11 (0.55)	14 (0.59)	27 (0.43)	10 (0.80)	19 (0.50)
16	Russia	117	18 (0.37)	11 (0.65)	36 (0.37)	18 (0.56)	13 (0.66)
17	Asia	109	11 (0.55)	22 (0.53)	27 (0.43)	15 (0.69)	21 (0.49)
18	Cretaceous	103	18 (0.37)	4 (0.94)	25 (0.46)	18 (0.56)	29 (0.43)
19	Tectonics	101	18 (0.37)	8 (0.77)	10 (0.70)	40 (0.35)	23 (0.47)
20	Arid area	98	18 (0.37)	25 (0.47)	57 (0.24)	34 (0.39)	15 (0.63)
21	Biogeography	98	11 (0.55)	14 (0.59)	12 (0.64)	22 (0.47)	31 (0.42)
22	Europe	93	56 (0.18)	123 (0.12)	27 (0.43)	16 (0.65)	27 (0.44)
23	Central Asia Orogenic Belt↑	92			57 (0.24)	30 (0.41)	13 (0.66)
24	Epidemiology	92	56 (0.18)	8 (0.77)	22 (0.49)	26 (0.43)	31 (0.42)
25	Holocene	86		28 (0.41)	111 (0.15)	34 (0.39)	18 (0.56)
26	Paleomagnetism↓	86		11 (0.65)	11 (0.67)	26 (0.43)	46 (0.32)
27	Irrigation	85	56 (0.18)	28 (0.41)	57 (0.24)	23 (0.45)	22 (0.48)
28	Distribution	82	18 (0.37)	28 (0.41)	67 (0.21)	26 (0.43)	25 (0.46)
29	Genetic diversity	81	18 (0.37)	123 (0.12)	52 (0.27)	23 (0.45)	23 (0.47)
30	Mitochondrial DNA	79		41 (0.29)	13 (0.61)	30 (0.41)	40 (0.34)

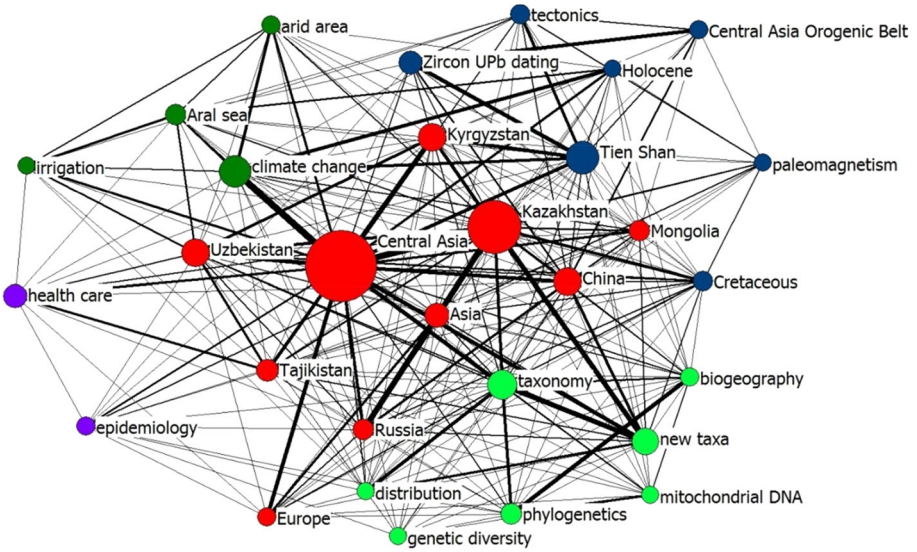

Fig. 3 Visualization of relationship among the top 30 keywords. The size of the nodes represented keyword frequencies, the thickness of *lines* indicated the tie strength between two keywords

"Kyrgyzstan", "Uzbekistan" and "Tajikistan", we found some keywords representative of geographical study area, such as "China", "Mongolia", "Russia", "Asia" and "Europe", which demonstrated the close relationship of Central Asian countries to the adjacent regions. Other 20 keywords mainly reflected research content and methods. The relationship among keywords revealed in Fig. 3 would suggest the research priorities of international community on different countries and regions. As for Central Asia, "climate change", "Tien Shan", "new taxa" and "taxonomy" attracted more attentions. For Kazakhstan, "new taxa" and "taxonomy" were the concerning focus. For Uzbekistan, "irrigation" and "Aral sea" were under emphasized. For Kyrgyzstan and Tajikistan, researchers primarily concentrated on "Tien Shan" and "health care" respectively. Furthermore, content analysis on keywords roughly told us four research directions of the field: (a) classification, phylogeny and distribution of biological population (keywords such as "taxonomy", "new taxa", "biogeography", "phylogenetics", "mitochondrial DNA"); (b) structural geology and geochemistry (such as "Tien Shan", "Central Asian orogenic belt", "tectonics", "zircon UPb dating"); (c) climate and ecological environment (such as "climate change", "Aral Sea", "arid area"); (d) epidemic diseases and health care (such as "epidemiology", "health care").

The temporal evolution of all keywords showed that some keywords frequencies increased obviously during the study period, such as "Tien Shan", "climate change" and "Central Asia Orogenic Belt" (Table 2). Central Asia is facing an unprecedented juxtaposition of regional climate- and water-related issues, emphasized by a changing climate (White et al. 2014). While, Tien Shan is the hot spot of global climate change and water cycle (Shen 2009). Both the percentages of "Tien Shan" and "climate change" rose steadily during the study period. "Central Asia Orogenic Belt" emerged in 2001, with its rank and percentage rising from 57th (0.24 %) in 2000–2004 to 30th (0.41 %) in 2005–2009 and then 13th (0.66 %) in 2010–2014. The significant growth indicated that,

Central Asia Orogenic Belt (CAOB) was receiving more and more attention. CAOB is distinguished from the others by its juvenile character and its unique role in the formation of the continental crust. It is very important to understand the origin, mechanism and dynamic evolution of CAOB (Xiao et al. 2012). Therefore, a boom in research on CAOB is expected in the future. In addition to the keywords on research objects, those on advanced techniques and methods also appeared, such as "Zircon UPb dating". Zircon UPb dating was one of the most ideal methods in isotope chronological study (Li 2009). Emerging in 1998, the rank and percentage of "Zircon UPb dating" rose from 123th (0.12 %) in 1995–1999 to 10th (0.98 %) in 2010–2014. On the other hand, the research topic "paleomagnetism" experienced a phase of ranking decline. Therefore, the topic did not seem promising avenues of Central Asia research.

Contribution of leading countries

Performance of research output

We extracted the information on geographic distribution based on authors' affiliations. A total of 145 countries/territories were involved, of which, the USA, countries from Central Asia and adjacent regions, and European countries were the leading contributors. The top ten most productive countries were listed in Table 3, with a total number of papers amounted to 8205, accounting for 74.4 % of the global aggregate.

In the study, we classified the top ten countries into three groups based on their scientific output. The USA and Russia had taken an absolute dominant position thus constituting the first group, and the papers kept steady rapid increase during 1990–2014 (Fig. 4). Meanwhile, the USA ranked the first concerning TP, TC and HCP, which showed that the USA was a powerful research force in the field. China, Germany, the UK and Kazakhstan were in the second group, with a total number of papers equivalent to that of the USA and Russia. The four countries published very few papers in 1990–1997, but increased slightly during 1998–2005 and achieved fast growing since 2006. China had undoubtedly contributed a lot to the Central Asia research with its fast growing papers ever since 2006,

Table 3 Top ten countries on Central Asia research based on total number of papers

Country	TP	TC	TC/TP	NCP	NCP %	HCP
USA	2400	56,181	23.41	337	14.04	82
Russia	2297	24,708	10.76	590	25.69	27
China	1461	27,029	18.50	304	20.81	47
Germany	1160	20,199	17.41	221	19.05	20
UK	1110	26,899	24.23	140	12.61	44
Kazakhstan	893	6337	7.10	326	36.51	3
France	593	20,345	34.31	71	11.97	32
Uzbekistan	564	4898	8.68	139	24.65	3
Japan	425	7327	17.24	59	13.88	12
Switzerland	329	9260	28.15	38	11.55	15
Global aggregate/average	11,025	148,430	13.46	2759	25.02	194

NCP number of non-cited papers, *NCR %* non-cited papers rate, *HCP* number of highly-cited papers (citations above 100)

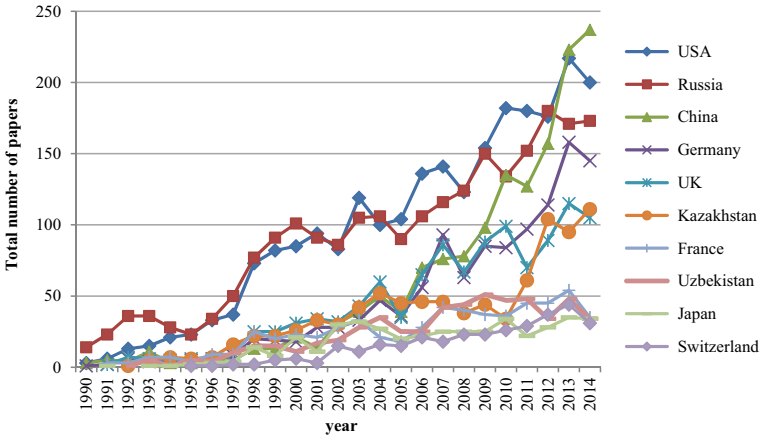

Fig. 4 The annual distribution of papers for top ten countries

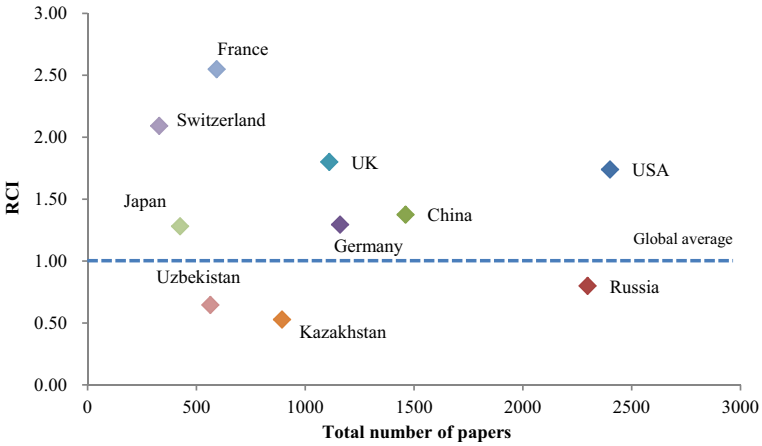

Fig. 5 Comparison of relative citation impact of papers for top ten countries

while it performed about flat on other indexes. France, Uzbekistan, Japan and Switzerland constituted the third group, their paper output maintained at a comparatively low level, and there was no significant increase during the study period.

Compared to other index, the average citation rate would probably serve as the most significant indicator to assess the quality and impact of papers for a research team. In this study, we used RCI (Relative Citation Impact) to measure the countries' academic impact. RCI referred to the ratio of average number of citations per paper for a research team to the corresponding global average value (Yi 2012). As was shown in Fig. 5, France led the list in terms of RCI, followed by Switzerland, the UK, the USA, China, Germany and Japan, while Kazakhstan, Uzbekistan and Russia were at the bottom, with RCI of 0.53, 0.65, 0.8 respectively.

Table 4 Most frequently used author keywords by the top ten countries

Country	Most frequently used keywords (top ten)
USA	Central Asia, Kazakhstan, climate change, Uzbekistan, China, Kyrgyzstan, Tien Shan, Tajikistan, HIV/AIDS, Mongolia
Russia	Central Asia, Kazakhstan, new taxa, taxonomy, Tien Shan, Russia, Cretaceous, Kyrgyzstan, Zircon UPb dating, paleomagnetism
China	Tien Shan, China, Zircon UPb dating, Central Asia, climate change, Xinjiang Uygur Autonomous Region, Central Asia Orogenic Belt, Tibetan Plateau and its adjacent regions, Geochemistry, granitoid
Germany	Central Asia, climate change, Uzbekistan, Tien Shan, Kazakhstan, Kyrgyzstan, Aral sea, taxonomy, paleoclimate, phylogenetics, Mongolia, Holocene
UK	Kazakhstan, Central Asia, health care, Kyrgyzstan, climate change, Soviet Union, Russia, Tajikistan, Tien Shan, Uzbekistan, Ordovician, Brachiopods
Kazakhstan	Kazakhstan, Central Asia, epidemiology, Aral sea, Remote Sensing, climate change, Echinococcus, incidence rate, children, Saiga tatarica
France	Central Asia, Kazakhstan, Tien Shan, tectonics, paleomagnetism, Aral sea, climate change, Holocene, Palaeozoic, China
Uzbekistan	Uzbekistan, Central Asia, irrigation, Aral sea, water resources, salinization, groundwater, cotton, Amu Darya, climate change
Japan	Central Asia, ultra-high pressure metamorphism, Kazakhstan, Kokchetav Massif, Uzbekistan, Semipalatinsk nuclear test site, Tien Shan, Zircon UPb dating, eclogite, climate change
Switzerland	Central Asia, Kyrgyzstan, climate change, epidemiology, Echinococcus, paleoclimate, Tajikistan, health care, Uzbekistan, Tien Shan

Research area

Table 4 listed the top ten most frequently used author keywords by the top ten countries. Overall, “Central Asia”, “Kazakhstan”, “Tien Shan”, and “climate change” were the common used keywords for almost all the countries. Besides, some focus of the countries showed obvious geographical characteristics and accorded with the country’s national conditions. For instance, Kazakhstan concerned more on epidemic diseases, health care for children, and endemic species (keywords such as “epidemiology”, “Echinococcus”, “incidence rate”, “children”, “Saiga tatarica”). While, Uzbekistan paid special attention on agriculture and water related topics (keywords such as “irrigation”, “Aral sea”, “water resources”, “salinization”, “groundwater”, “cotton”, “Amu Darya”). Japan focused on “ultra-high pressure metamorphism”, “Kokchetav Massif” and “eclogite”. Furthermore, “Semipalatinsk nuclear test site” was also a matter of concern, indicating that Japan laid much stress on nuclear safety.

Contribution of leading institutions

Performance of research output

The top ten most productive institutions altogether contributed 3229 papers, with an average of 322.9 papers per institution. Only two institutions had produced more papers than the group’s average (Table 5). In the past 25 years, Russian Academy of Sciences (RAS) had a notable advantage in Central Asia research due to its largest number of papers

Table 5 Top ten institutions on Central Asia research based on total number of papers

Institution	TP	TC	TC/TP	NCP	NCP %	HCP
Russian Academy of Sciences (RAS)	1523	17,215	11.30	332	21.80	14
Chinese Academy of Sciences (CAS)	751	14,489	19.29	146	19.44	24
University of California System (UCs)	235	9403	40.01	21	8.94	12
Lomonosov Moscow State University (MSU)	219	1871	8.54	75	34.25	3
Academy of Sciences of Uzbekistan (UAS)	212	2161	10.19	59	27.83	2
National Academy of Sciences of Kazakhstan (KAS)	146	1656	11.34	38	26.03	0
Chinese Academy of Geological Sciences (CAGS)	139	3952	28.43	18	12.95	11
French National Centre for Scientific Research (CNRS)	136	4767	35.05	11	8.09	10
Peking University (PU)	116	3164	27.28	15	12.93	8
Lanzhou University (LU)	115	1287	11.19	23	20.00	2
Global aggregate/average	11,025	148,430	13.46	2759	25.02	194

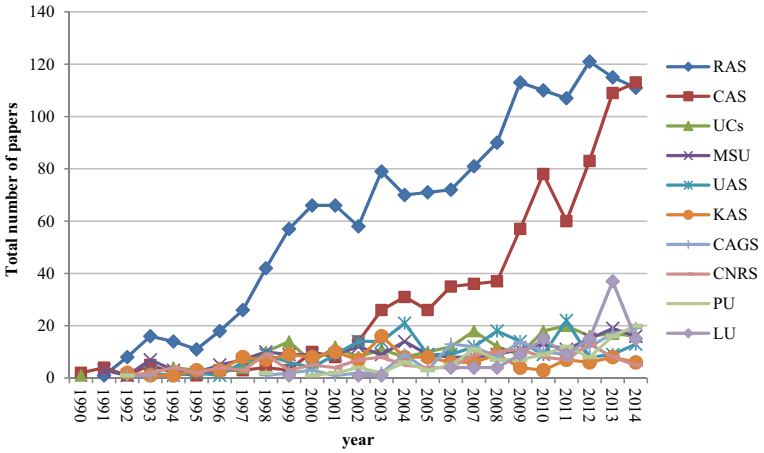

Fig. 6 The annual distribution of papers for top ten institutions

(1523) and citations (17,215), as well as the clearly growth trend ever since 1991 (Fig. 6). Taking the second rank with 751 papers and 14,489 citations, Chinese Academy of Sciences (CAS) had chased up rapidly albeit from a low base. The other eight institutions constituted the third group, with papers all <250, and showed stable development without obvious increase in the whole study period.

Higher TC/TP value than group's average of 15.76 had been scored by five institutions. They were University of California System (UCs) (40.01), French National Centre for Scientific Research (CNRS) (35.05), Chinese Academy of Geological Sciences (CAGS) (28.43), Peking University (PU) (27.28), and CAS (19.29) respectively. These five institutions achieved higher RCI value than the global average (Fig. 7).

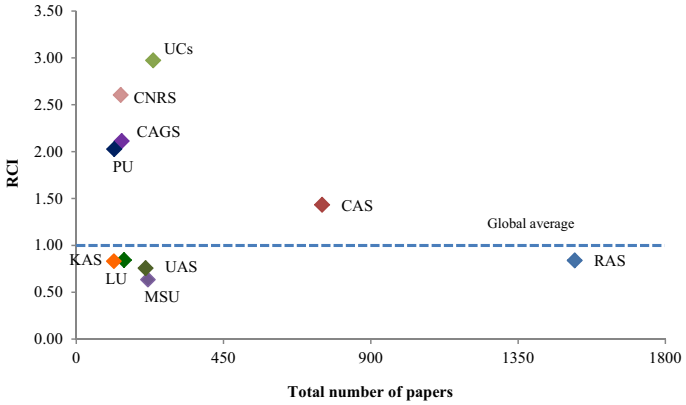

Fig. 7 Comparison of relative citation impact of papers for top ten institutions

Table 6 Most frequently used author keywords by the ten institutions

Institutions	Most frequently used keywords (top ten)
RAS	Central Asia, Kazakhstan, new taxa, Cretaceous, Tien Shan, taxonomy, Asia, paleomagnetism, Kyrgyzstan, Zircon UPb dating
CAS	Tien Shan, China, Central Asia, climate change, Zircon UPb dating, Tibetan Plateau and its adjacent regions, Xinjiang Uygur Autonomous Region, arid area, Central Asia Orogenic Belt, tectonics
UCs	Central Asia, Tien Shan, Uzbekistan, HIV/AIDS, Kazakhstan, China, glaciation, climate change, taxonomy, paleomagnetism
MSU	Kazakhstan, Central Asia, taxonomy, Tajikistan, morphology, new taxa, Apiaceae, biogeography, Bothriolepis, Placodermi
UAS	Central Asia, Uzbekistan, Aral sea, heavy metal, salinization, taxonomy, Umbelliferae, alkaloids, fatty acids, lipids
KAS	Kazakhstan, epidemiology, Echinococcus, phylogenetics, Central Asia, biogeography, Ordovician, Brachiopods, Saiga tatarica, Goitered gazelle
CAGS	Zircon UPb dating, Central Asia Orogenic Belt, China, Tien Shan, granitoid, Xinjiang Uygur Autonomous Region, Geochemistry, Palaeozoic, Sr–Nd–Pb–Hf isotope, tectonics
CNRS	Central Asia, paleomagnetism, tectonics, Tien Shan, Holocene, climate change, Geochemistry, magnetostratigraphy, Cretaceous, Caspian sea
PU	Tien Shan, Central Asia Orogenic Belt, Zircon UPb dating, Palaeozoic, Geochemistry, granitoid, tectonics, Central Asia, China, paleomagnetism
LU	Holocene, climate change, arid area, Tibetan Plateau and its adjacent regions, monsoon, Central Asia, Qaidam Basin, lake sediments, vegetation dynamics, paleoclimate

Research area

The research interests of the top ten institutions performed by various keywords. As revealed in Table 6, CAGS was closely related to Peking University due to the similar topics, both the two institutions laid emphasis on geological research (keywords such as "Central Asia Orogenic Belt", "Zircon UPb dating", "Tien Shan", "Palaeozoic", "Geochemistry", "granitoid", "tectonics"). MSU and KAS focused on classification, morphology and distribution of different populations (such as "taxonomy",

Table 7 Top 20 authors on Central Asia research based on total number of papers

Author	Institution	TP	TC	TC/TP	H-index
Averianov AO	Russian Acad Sci, Russia	60	673	11.22	16
Xiao WJ	Chinese Acad Sci, China	52	3219	61.90	24
Lamers JPA	Univ Bonn, Germany	50	418	8.36	12
Yarmolyuk VV	Russian Acad Sci, Russia	49	491	10.02	13
Mckee M	Univ London, UK	42	647	15.40	15
Kotov AB	Russian Acad Sci, Russia	39	409	10.49	12
Kovach VP	Russian Acad Sci, Russia	38	507	13.34	14
Fedotova ZA	Samara Agr Acad, Russia	37	24	0.65	2
Sal'nikova EB	Russian Acad Sci, Russia	37	347	9.38	11
Buslov MM	Russian Acad Sci, Russia	36	967	26.86	17
Degtyarev KE	Russian Acad Sci, Russia	35	394	11.26	9
Popov LE	Natl Museum Wales, UK	34	323	9.50	12
Windley BF	Univ Leicester, UK	32	3772	117.88	26
Li ZQ	Chinese Acad Sci, China	29	267	9.21	9
Bazhenov ML	Russian Acad Sci, Russia	28	771	27.54	17
Milner-Gulland EJ	Univ London Imperial Coll Sci Technol and Med, UK	27	513	19.00	16
Han CM	Chinese Acad Sci, China	27	1454	53.85	14
Kozakov IK	Russian Acad Sci, Russia	26	279	10.73	10
Sobolev NV	Russian Acad Sci, Russia	26	809	31.12	16
Martius C	Univ Bonn, Germany	26	233	8.96	10

"morphology", "new taxa", "Apiaceae", "Placodermi", "biogeography", "phylogenetics", "Saiga tatarica", "Goitered gazelle"). Lanzhou University emphatically studied the climate and ecological environment of Central Asia (such as "climate change", "arid area", "monsoon", "vegetation dynamics", "lake sediments", "paleoclimate"). In addition, UCs was the only institution showing solicitude for epidemiology of HIV/AIDS.

Contribution of leading authors

The analyzed paper records listed 28,163 authors, among whom 21,414 (76 %) had produced only one paper and a total of 25,266 (90 %) had produced <3 papers. The top 20 most productive authors altogether contributed 553 papers, accounting for 5 % of cumulative publications. Among these 20 authors, 11 were from Russia, 4 from the UK, 3 from China, others 2 from Germany.

The three most productive authors were Averianov AO from Russian Academy of Sciences, Russia, Xiao WJ from Chinese Academy of Sciences, China and Lamers JPA from University of Bonn, Germany, with 60, 52 and 50 published papers respectively (Table 7). Considering the total citations, average citations and H-index comprehensively, Windley BF from University of Leicester, UK, and Xiao WJ were outstanding in this review. As for Windley BF, he is a British famous geologist and tectonic expert, and had been the president of International Association for Gondwana Research. Eight of his 32 papers were cited more than 100 times each. Xiao WJ is an important co-author for

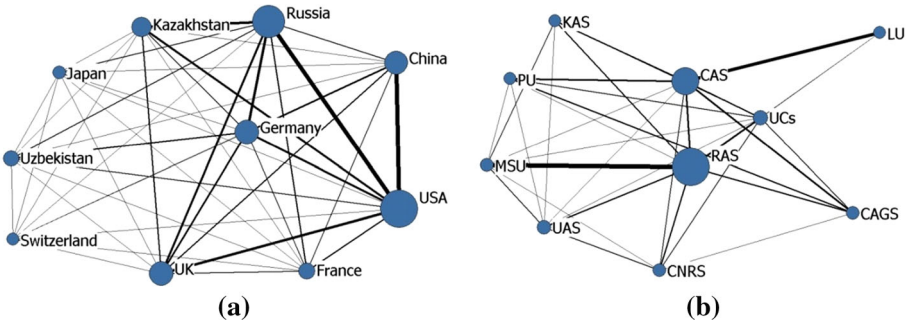

Fig. 8 Visualization of research collaboration among **a** top ten countries, **b** top ten institutions. The size of the nodes indicated the number of collaborated papers, and the thickness of *lines* denoted the collaboration intensity

Windley BF and they together published 12 papers on Central Asia. Xiao WJ laid particular attention on tectonics of the Tethys and accretionary orogenesis and metallogeny in Central Asia. All of his papers were published after 2001, and 28 were published in the recent five years, which indicating his emerging role in this field.

Collaboration network

Collaborations in research provide an opportunity to increase the impact and scope of research. In general, the most direct output for scientific collaboration is the co-authored papers. In this view, 2547 (23.1 %) of the total 11,025 papers were independently prepared by single author, other 8478 (76.9 %) were co-authored ones. Within the 9832 papers with author addresses, 4058 (41.3 %) were single institution papers and 5616 (57.1 %) were single country papers. Namely, 5774 (58.7 %) were inter-institutionally collaborative ones and 4216 (42.9 %) were internationally collaborative ones.

The collaboration network of the top ten most productive countries and institutions were visualized using UCINET respectively. As observed from the high density link lines in Fig. 8a, collaborations among these ten countries were quite frequent. USA, with the largest number of international collaboration papers, was also the principal collaborator with other counties, collaborating closely with China, Russia, the UK, Germany and Kazakhstan. China was more engaged in collaboration with the USA, the UK and Germany. Russia worked closely with the USA, the UK, Germany and Kazakhstan. Additionally, there were also important tie between Germany and the UK. As for institutions (Fig. 8b), RAS and CAS were the principal collaborators with others. Meanwhile, the degree of collaborations among internal institutions was higher than that of collaborations among international institutions, such as the intensive collaboration among CAS, LU, CAGS and PU, as well as between RAS and MSU.

Conclusion

This study conducted a bibliometric analysis of Central Asia research during 1990–2014. Basic concepts, current progress and trends, research forces comparison were presented as a way to understand the situation in the field.

According to the study, Central Asia research was marked by stable growth with increasing publications. A total of 11,025 papers were published in 2356 journals and were listed with 214 Web of Science categories. Zoologichesky Zhurnal was the most popular journal that researchers chose to publish their research results, while Earth and Planetary Science Letters had greater influence in the field with a large number of citations. Geosciences Multidisciplinary, Geochemistry and Geophysics, Paleontology, Environmental Sciences and Zoology were the top five most productive subject categories. Keyword analysis indicated that, "Central Asia", "Kazakhstan", "Kyrgyzstan", "Uzbekistan" and "China" were the most attractive study areas, "Tien Shan", "climate change", "taxonomy", "new taxa", and "health care" were the most concerned research areas. Besides, temporal evolution of keywords revealed the rapid growth of "Central Asia Orogenic Belt" and "Zircon UPb dating" due to the increasing publications, while"paleomagnetism" was experiencing a phase of ranking decline.

Of 145 countries/territories participating in Central Asia research, the USA and Russia took a dominant position by contributing more papers, followed by China, Germany, the UK, Kazakhstan, France, Uzbekistan, Japan and Switzerland. However, France was the leading country in terms of citation impact. In addition, the research collaboration among the top ten countries was quite frequent, and USA was the principal collaborator with other counties. At the institutional level, Russian Academy of Sciences contributed the most papers on Central Asia, and University of California System had the most leverage concerning citations. In terms of authors, Averianov AO from Russia published the most papers, while Windley BF from the UK and Xiao WJ from China were more competitive due to their larger number of citations and higher H-indexes.

The analysis in this paper, however, was based on the SCI-Expanded and SSCI databases, which did not contain the entire literatures of this field from 1990 to 2014, especially the lack of Russian and Chinese publications. This coverage inadequacy should be supplemented by retrieving some other databases or materials, which would be beneficial to the rationality of the result. Nevertheless, this bibliometric study utilized indispensable research tool to get a global overview of the current progress and trends in Central Asia research field. In spite of the limitation due to the scope of the retrieved bibliographic material, this paper provided a good starting point to understand the evolution of research in the field and might serve as a potential basis for future research.

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