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What is the difference in global research on Central Asia before and after the collapse of the USSR: a bibliometric analysis

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Abstract
Central Asia currently plays an important role on the global stage due to its geographical position and the region has been receiving increased research attention. We conducted a bibliometric analysis for the years 1900–2016 to evaluate differences in global research on Central Asia before and after the collapse of the Union of Soviet Socialist Republics (USSR), based on the Science Citation Index Expanded (SCIE) and Social Science Citation Index (SSCI) databases. This paper adopted a comparative analysis approach and summarized publication outputs, subject categories, country productivity, collaborations, title keywords and institution productivity on Central Asia before and after the collapse of the USSR. We analyzed the relationship between global research outputs on Central Asia and relevant impact factors, including the number of tourists, exports of fuel oil and gross domestic product (GDP). Comparing results before and after the collapse of the USSR, our bibliometric analysis revealed the following: (1) publications on Central Asia experienced a meteoric growth and publications in the SCIE played a dominant role after the collapse of the USSR; (2) Geology, Environmental Sciences & Ecology and Paleontology increased the most while Science & Technology—Other Topics, Geography and Anthropology decreased dramatically; (3) research countries became increasingly diversified and publications were produced by increasing numbers of international collaborations with a diversification of major collaborators; (4) the focus of title keywords differed before and after the collapse of the USSR; (5) institutions became more diversified and most of them focused on natural sciences; (6) there were high correlations between publications on Central Asia and the number of tourists, exports of fuel oil and GDP. These results reflect the close relationship between scholarly outputs on Central Asia and relevant factors, including the number of tourists, export of fuel oil and GDP. Increasing scholarly outputs on Central Asia therefore had a positive impact on global Central Asia research.

Keywords Central Asia · Union of Soviet Socialist Republics (USSR) · Bibliometrics · SCIE · SSCI

Introduction

Central Asia (sometimes called Middle Asia) is the core region of the Asian continent that stretches from the Caspian Sea to the west to China, and from Afghanistan in the south to Russia in the north. Central Asia is defined by the Soviet Union and includes the following four republics: Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. After the collapse of the Union of Soviet Socialist Republics (USSR) on 25 December 1991, leading to the countries' independence, the leaders of the four former Soviet Central Asian Republics met in Tashkent, Uzbekistan and declared that the definition of Central Asia should include Kazakhstan (Weeks 2004).

Since then, Central Asia became the generic term to cover five independent countries (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan) and this has become the most common definition of Central Asia. Currently, Central Asia plays an important role in the world due to its geographical position and it has been receiving increasing attention (Hanks 2009). Research on Central Asia encompasses multiple fields, including natural and societal sciences such as geology (Chlachula 2010), chemistry (Zhang et al. 2013), agriculture (Devkota et al. 2013), water resources (Rahaman 2012), zoology (Terraube et al. 2010) and history (Howard-Johnston 2013). Moreover, some research combines the physical sciences with the humanities, such as studies of resource and environment regulations (Zakhirova 2013), environmental sciences and ecology (Alamanov and Mikkola 2011), and disease and policy (Jolley et al. 2012). Since 2013, when the Chinese government implemented the "One Belt One Road Initiative", more people have been paying attention to Central Asia. So far, however, there is little discussion about comparison and analysis of the global research on Central Asia before and after the collapse of the USSR. In this paper, we conduct exhaustive bibliometric analyses on Central Asia and discuss global research emphases in the variously socio-economic context. Moreover, this paper attempts to reveal a close relationship between scholarly outputs on Central Asia and relevant factors (incl. the number of tourist, export of the fuel oil and GDP).

Bibliometrics is a set of effective tools that use quantitative analysis to depict research trends in the scientific and technological literature in different fields (Hsieh et al. 2004; Chen et al. 2005). Bibliometric methods emphasize statistical analyses and mostly use figures and tables to describe basic patterns in research trends such as publication outputs, authors, countries and collaboration (Abramo et al. 2011; Wang et al. 2009).

In this study, we use bibliometric analysis to explore global research trends on Central Asia before and after the collapse of the USSR using the Science Citation Index Expanded (SCIE) and Social Science Citation Index (SSCI) databases from 1900 to 2016. In this paper, we assess comparative research patterns from 1900 to 1991 and from 1992 to 2016 by analyzing publication outputs, subject categories, country productivity, collaboration, title keywords and institution outputs. We also analyze relationships between global Central Asia research outputs and a number of impact factors, including the number of tourists, exports of fuel oil and gross domestic product (GDP). Our analysis summarizes global research trends, reveals underlying factors and identifies areas for further research.

Materials and methods

We obtained data sources from the SCIE and SSCI in the Web of Science. The search terms "Kirghiz*", "Kyrgy*", "Kirgiz*", "Tajik*", "Tadzhik*", "Turkmen*", "Turkman*", "Turkoman*", "Turkomen*", "Kazak*", "Uzbek*", "Central Asia" and "Middle Asia" were selected as search terms in the titles, abstracts and keywords of journal articles. We searched for publications published between 1900 and 2016. Because the USSR collapsed on 25 December 1991, the year 1992 was considered as the breaking point for comparative analyses between the two time periods. We divided the research period into two stages: the period 1900–1991 was defined as stage I and the period 1992–2016 was defined as stage II.

Publications originating from England, Scotland, Northern Ireland and Wales were considered to be from the United Kingdom (UK), while Hong Kong, Macau and Taiwan were distinguished from mainland China due to differences in their political systems. Given that we focused on the analysis and discussion for the differences of global research on Central Asia before and after the USSR dissolution in this paper, we regard these Soviet Socialist Republic (SSR) countries as the individual country/territory for the international productivity and collaboration analysis. The collaboration type of countries was determined by the addresses of the authors. Title keyword analyses selected keywords and excluded empty words like "the", "of", "on" and etc. The title word analysis contained words that appeared only in the title.

Results and discussion

Characteristics of research outputs

There were 2710 publications on Central Asia in stage I, with 1953 SCIE publications and 826 SSCI publications. Among the publications, 69 publications were in both the SCIE and SSCI. There were 15,726 publications on Central Asia in stage II, with 13,072 SCIE publications and 3911 SSCI publications, including 1257 publications that were in both the SCIE and SSCI. Global research outputs of the SCIE and SSCI and Central Asia publications increased from 1900 to 2016, with more rapid growth in stage II compared with stage I (Fig. 1).

In stage I, publications did not increase until 1964. The average annual growth rate of the total publications of the SCIE and SSCI reached 4.91% from 1964 to 1991, while it was 3.80% from 1900 to 1963. From 1964 to 1991, the total publication growth rate for research on Central Asia had an average annual growth rate of 6.73%, much faster than the overall publication growth rate of the SCIE and SSCI (4.91%). The contributions of the total publications on Central Asia mainly stemmed from publications in the SCIE, which grew faster than the SSCI with average annual growth rates of 9.62% and 0.94% from 1964 to 1991, respectively.

Stage II (1992–2016) showed high growth rates for Central Asia research. Total publications on Central Asia had an average annual growth rate of 6.15%, much faster than the growth rate of the total publications of the SCIE and SSCI (4.10%). The publication growth curve of the SCIE for Central Asia is steeper (with a greater slope) than that of the SSCI after the dissolution of the USSR. In addition, the trend of the growth curve of SCIE is similar to that of the total publications on Central Asia. Our results indicate that research

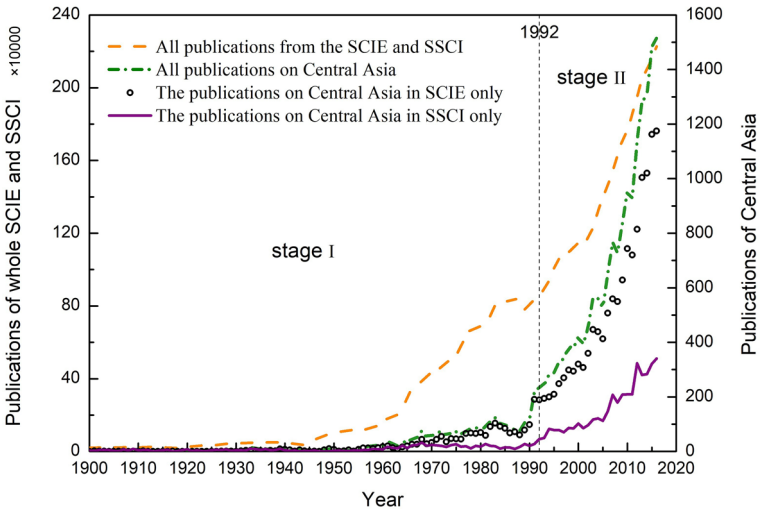

Fig. 1 Global research outputs of Science Citation Index Expanded (SCIE), Social Science Citation Index (SSCI) and publications on Central Asia in 1900–2016

trends in the sciences had a steady-state growth in recent years based on the large number of previous studies. In addition, the SCIE played a dominant role in research on Central Asia.

Subject categories

In stage I, publications on Central Asia covered 94 subject categories in the Web of Science. The six most significant categories in the study of Central Asia in terms of publication numbers and percent representation were Science & Technology—Other Topics (585 publications, 18.51% of the total), Geography (241, 7.63%), Geochemistry & Geophysics (223, 7.06%), Geology (182, 5.76%), Zoology (178, 5.63%) and Anthropology (154, 4.87%). Each of these six categories had at least 100 publications. The annual publication outputs of these six subject categories showed robust growth from 1900 to 1991 and these top six subject categories comprised 49.46% of all publications in this period.

In stage II, we identified 145 subject categories referring to Central Asian research in the Web of Science. The six most significant categories in the study of Central Asia in terms of publication numbers and percent representation were Geology (2553 publications, 11.19% of the total), Environmental Sciences & Ecology (1232, 5.40%), Geochemistry & Geophysics (1195, 5.24%), Government & Law (813, 3.57%), Paleontology (809, 3.55%) and Zoology (804, 3.53%). Each of these six categories had at least 800 publications. The growth rate of annual publications within these six subject categories increased in stage II. Publications belonging to these six categories comprised 32.48% of all publications during this period. The proportion of Geology and Environmental Sciences & Ecology publications increased from 5.76 and 1.30%, respectively, in stage I, to 11.19% and 5.40%, respectively, in stage II.

Comparing the subject category analyses in stage II with stage I reveals some striking differences (Table 1). First, Geology, Environmental Sciences & Ecology, Paleontology

Table 1 The top 20 most productive subject categories in the study of Central Asia in 1900–2016

R	1900–1991		1992–2016	
	SC	TP (%)	SC	TP (%)
1	Science & Technology—other topics	585 (18.51)	Geology	2553 (11.19)
2	Geography	241 (7.63)	Environmental Sciences & Ecology	1232 (5.40)
3	Geochemistry & Geophysics	223 (7.06)	Geochemistry & Geophysics	1195 (5.24)
4	Geology	182 (5.76)	Government & Law	813 (3.57)
5	Zoology	178 (5.63)	Palaeontology	809 (3.55)
6	Anthropology	154 (4.87)	Zoology	804 (3.53)
7	Area Studies	93 (2.94)	Business & Economics	768 (3.37)
8	Agriculture	86 (2.72)	Area Studies	638 (2.80)
9	Government & Law	79 (2.50)	Physical Geography	609 (2.67)
10	Engineering	74 (2.34)	Plant Sciences	601 (2.64)
11	Genetics & Heredity	69 (2.18)	Agriculture	572 (2.51)
12	Business & Economics	64 (2.02)	Engineering	524 (2.30)
13	Parasitology	58 (1.84)	Public, Environmental & Occupational Health	488 (2.14)
14	Chemistry	55 (1.74)	Science & Technology—other topics	477 (2.09)
15	History	52 (1.65)	International Relations	465 (2.04)
16	Infectious Diseases	51 (1.61)	Genetics & Heredity	433 (1.90)
17	Palaeontology	48 (1.51)	Meteorology & Atmospheric Sciences	396 (1.74)
18	General & Internal Medicine	44 (1.39)	Anthropology	390 (1.71)
19	Environmental Sciences & Ecology	41 (1.30)	Mineralogy	384 (1.68)
20	Entomology	35 (1.11)	Water Resources	371 (1.63)

SC subject categories, *TP* total publications, *R* rank

and Business & Economics had the highest increases compared with stage I and these subjects ranked in the top seven categories in stage II. Second, Science & Technology—Other Topics, Geography and Anthropology, which were in the top six ranking in stage I, decreased in rank and were respectively ranked 14, 27 and 18 in stage II. Finally, the subject categories of Parasitology, Chemistry, History, Infectious Diseases, General & Internal Medicine and Entomology ranked in the top 20 in stage I but were not in the top 20 subject categories in stage II. Public, Environmental & Occupational Health, International Relations, Meteorology & Atmospheric Sciences, Mineralogy and Water Resources ranked in the top 20 in stage II but were not in the top 20 in stage I.

Country productivity and collaborations

We extracted the author affiliations of each country/territory and plotted a global geographical distribution map of publications (Fig. 2). The map clearly indicates the difference of distribution of publications in global research on Central Asia before and after USSR collapse. The distribution of authors and countries greatly increased in stage II compared with stage I.

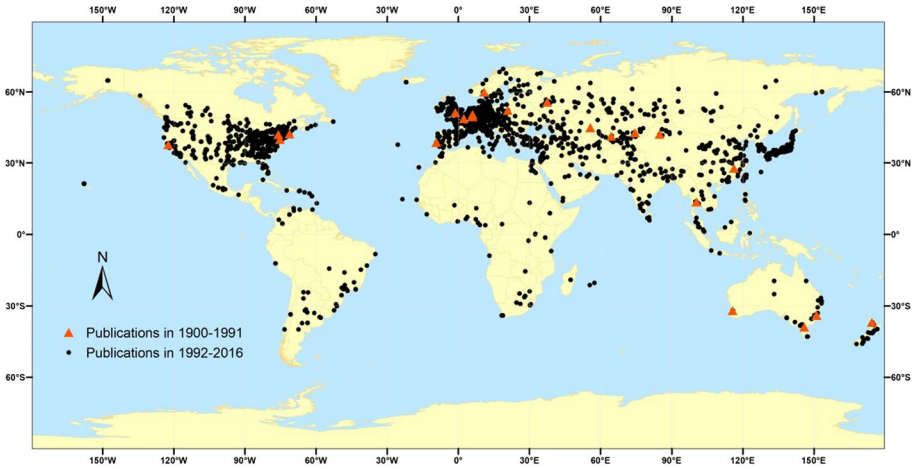

Fig. 2 Global geographic distribution of publications on Central Asia

Table 2 shows the top 20 most productive countries in the study of Central Asia in stage I. It can be found that the USSR (880 publications), the United States of America (USA; 222), the Kazakh Soviet Socialist Republic (KASSR; 112), the Uzbek Soviet Socialist Republic (UZSSR; 76) and the Tajik Soviet Socialist Republic (TASSR; 72) were the five most productive countries. There were 1459 (86.03%) single-country publications, but only 237 of the 1696 publications (13.97%) that had country information involved international collaborations. Additionally, the collaboration network of the countries/territory in stage I was visualized in Fig. 3. The sizes of the nodes symbolize the amount of articles of each country, and the strength of collaboration can be represented by the thickness of interconnecting lines. As can be seen, the USSR took a core position in the collaboration network in stage I. It was identified as the principal collaborator with the main productive countries, such as USA, KASSR, UZSSR, TASSR and Kirghiz Soviet Socialist Republic (KISSR) on Central Asian research.

The top five countries listed based on total publications in stage II differed from those in stage I (Table 3). The productivity rank of countries was led by the USA with 3488 articles. Russia took second place in publication output (3155 publications), followed by China (2337), Germany (1629), and Kazakhstan (1566). Of the publications in stage II, 8822 (36.31%) were single-country publications and 15,471 (63.93%) were internationally co-authored articles. As shown in Fig. 4, collaborations among the productive countries were frequent in stage II. According to the node sizes, thickness and density of the link lines, we can identify that there are much more countries, such as the USA, Russia, China, Germany and Kazakhstan took part in international cooperation. The USA and Russia took the central position in the collaboration network with other productive countries.

When comparing country productivity and collaboration in stage II and stage I, we found that research countries became increasingly diversified. Within the 20 most productive countries in stage II, ten countries were from Europe, seven from Asia, two from North America, and one from Oceania. The eight major industrial countries (the G8: the USA, the UK, Germany, Canada, France, Italy, Japan and Russia) were all included in the top 20 most productive countries, while countries from the former USSR held the largest proportion of publications in stage I.

Table 2 The top 20 most productive countries in the study of Central Asia in 1900–1991

Countries	TP	*R* (%)	Single country		International collaboration			
			SP	%	CP	%	MC (P)	
USSR	880	1 (51.89)	801	91.02	79	8.98	USA	20
USA	222	2 (13.09)	187	84.23	35	15.77	USSR	20
KASSR	112	3 (6.60)	101	90.18	11	9.82	USSR	11
UZSSR	76	4 (4.48)	63	82.89	13	17.11	USSR	12
TASSR	72	5 (4.25)	58	80.56	14	19.44	USSR	11
KISSR	49	6 (2.89)	37	75.51	12	24.49	USSR	10
UK	49	7 (2.89)	41	83.67	8	16.33	China	6
TUSSR	29	8 (1.71)	17	58.62	12	41.38	USSR	9
Czechoslovakia	27	9 (1.59)	22	81.48	5	18.52	USSR	3
Canada	24	10 (1.42)	21	87.50	3	12.50	USA	2
UKSSR	24	11 (1.42)	21	87.50	3	12.50	USSR	2
France	21	12 (1.24)	11	52.38	10	47.62	USA	4
China	13	13 (0.77)	2	15.38	11	84.62	UK	6
FED REP GER	11	14 (0.65)	11	100	0	0.00	NA	NA
Japan	8	15 (0.47)	6	75	2	25.00	USSR	2
Norway	8	16 (0.47)	6	75	2	25.00	USA	2
GER DEM REP	6	17 (0.35)	5	83.33	1	16.67	France	1
India	6	18 (0.35)	6	100	0	0.00	NA	NA
Germany	5	19 (0.29)	2	40	3	60.00	USSR	3
Israel	4	20 (0.24)	4	100	0	0.00	NA	NA

TP total publications, *SP* single-country publications, *CP* publications with international collaborations, *MC* (P) major collaborator (i.e. the number of articles between two countries that were collaborated on), *USA* United States of America, *UK* United Kingdom, *USSR* Union of Soviet Socialist Republics, *KASSR* Kazakh Soviet Socialist Republic, *UZSSR* Uzbek Soviet Socialist Republic, *TASSR* Tajik Soviet Socialist Republic, *KISSR* Kirghiz Soviet Socialist Republic, *TUSSR* Turkmen Soviet Socialist Republic, *UKSSR* Ukrainian Soviet Socialist Republic, *FED REP GER* Federal Republic of Germany, *GER DEM REP* Germany Democratic Republic

Internationally co-authored publications increased from 13.97% in stage I to 63.69% in stage II. In stage I, researchers were more inclined to produce single-country publications. This may be explained by a number of underlying factors, including the East–West Cold War. Before the disintegration of the Soviet Union, the United States and the Soviet Union were the two superpowers in the world. To contend for world hegemony, these two countries and their allies struggled for several decades. At the same time, the Soviet Union tightened its diplomatic policy with some countries, influencing scientific research (Costa 2018). Additionally, due to the single pattern of economic development and low level of informatization, the international cooperation activities were less frequent in that time under this general background. Collaborators diversified in stage II, while almost all collaborations occurred within the former Soviet Union and the USA in stage I (Figs. 3 and 4). This distinguished variation on the internationally co-authored research can be explained by the following reasons. In the past several decades, with the development and acceleration of economic globalization, the technology globalization was becoming a significant form of economic globalization. The globalization of scientific activities impelled the development of international scientific communication and created a lot of opportunities

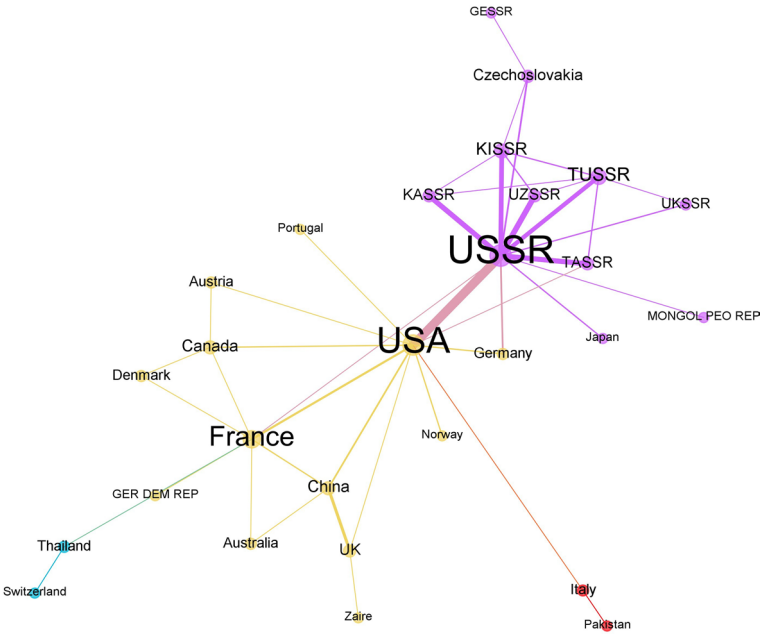

Fig. 3 Collaboration network of the productive countries/territories in 1900–1991

for collaboration in scientific research among the countries (Choi 2011; Zhuang et al. 2015). Based on this background, the diversification of Central Asia research collaboration during 1992 to 2016 was accordant to the international situation, and the international cooperation was expanding correspondingly. In addition, the geographical advantages of Central Asia were beginning to be valued, more and more countries were interested in the research on Central Asia and the international cooperation was enhanced as well. Furthermore, since Central Asian countries gained independence respectively after the collapse of the Soviet Union, the governments rolled out a couple of new diplomatic strategies to promote cooperation with other countries, which might stimulate more scientific cooperation.

Title keywords

As keywords and keywords plus rarely appeared before 1991, we used title words in publications on Central Asia in the SCIE and SSCI for our keyword analysis. Central Asia can be analyzed from the two perspectives of the physical sciences and social sciences, which can help us understand publication themes and grasp the general direction of the study of Central Asia (Fig. 5).

We found several differences when comparing the subject title keyword analyses for SCIE in stage II with those in stage I. First, countries of concern to the USSR and SSR in stage I became China and the five Central Asian countries. They were at the top of the ranking in stage II. The most popular research topics in Central Asian countries and China focused on subjects related to geology, geochemistry, geophysics, paleontology, environmental sciences, ecology and physical geography, such as the study of accretionary orogenesis, the North China Craton, paleobiogeography, and environmental and climatic

Table 3 The top 20 most productive countries in the study of Central Asia in 1992–2016

Countries	TP	*R* (%)	Single country		International collaboration			
			SP	%	CP	%	MC (P)	
USA	3488	1 (14.36)	1593	45.67	1895	54.33	China	409
Russia	3155	2 (12.99)	1557	49.35	1598	50.65	USA	387
China	2337	3 (9.62)	1203	51.48	1134	48.52	USA	409
Germany	1629	4 (6.71)	518	31.80	1111	68.20	Russia	241
Kazakhstan	1566	5 (6.45)	601	38.38	965	61.62	Russia	270
UK	1564	6 (6.44)	578	36.96	986	63.04	USA	224
Uzbekistan	795	7 (3.27)	281	35.35	514	64.65	Germany	129
France	783	8 (3.22)	167	21.33	616	78.67	Russia	132
Japan	581	9 (2.39)	171	29.43	410	70.57	China	94
Kyrgyzstan	539	10 (2.22)	111	20.59	428	79.41	Russia	118
Canada	452	11 (1.86)	135	29.87	317	70.13	USA	93
Switzerland	451	12 (1.86)	81	17.96	370	82.04	Germany	88
Australia	439	13 (1.81)	124	28.25	315	71.75	China	99
Italy	407	14 (1.68)	109	26.78	298	73.22	USA	75
Turkey	375	15 (1.54)	205	54.67	170	45.33	Kazakhstan	34
Netherlands	326	16 (1.34)	61	18.71	265	81.29	Germany	63
Iran	291	17 (1.20)	142	48.80	149	51.20	USA	42
Sweden	284	18 (1.17)	47	16.55	237	83.45	UK	62
Spain	275	19 (1.13)	75	27.27	200	72.73	Russia	42
Poland	245	20 (1.01)	96	39.18	149	60.82	Russia	58

TP total publications, *SP* single-country publications, *CP* publications with international collaborations, *MC* (P): major collaborator (i.e. the number of articles between two countries that were collaborated on); *USA* United States of America, *UK* United Kingdom

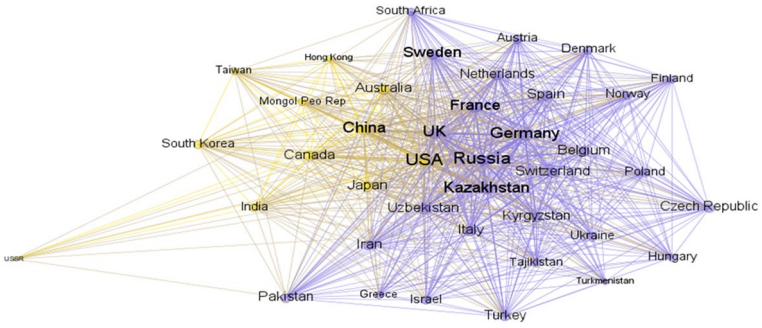

Fig. 4 Collaboration network of the productive countries/territories in 1992–2016

changes (Xiao et al. 2008; Zhang 2012; Li et al. 2014; An et al. 2012). These five subjects accounted for ~ 30% of publications on Central Asia in stage II.

The ranking order of orientation nouns in stage I (i.e. "southern", "western", "northern", and "eastern") changed to "northern", "eastern", "western", and "southern" in stage II. The regional orientation of the research of Central Asia shifted from the southwest to

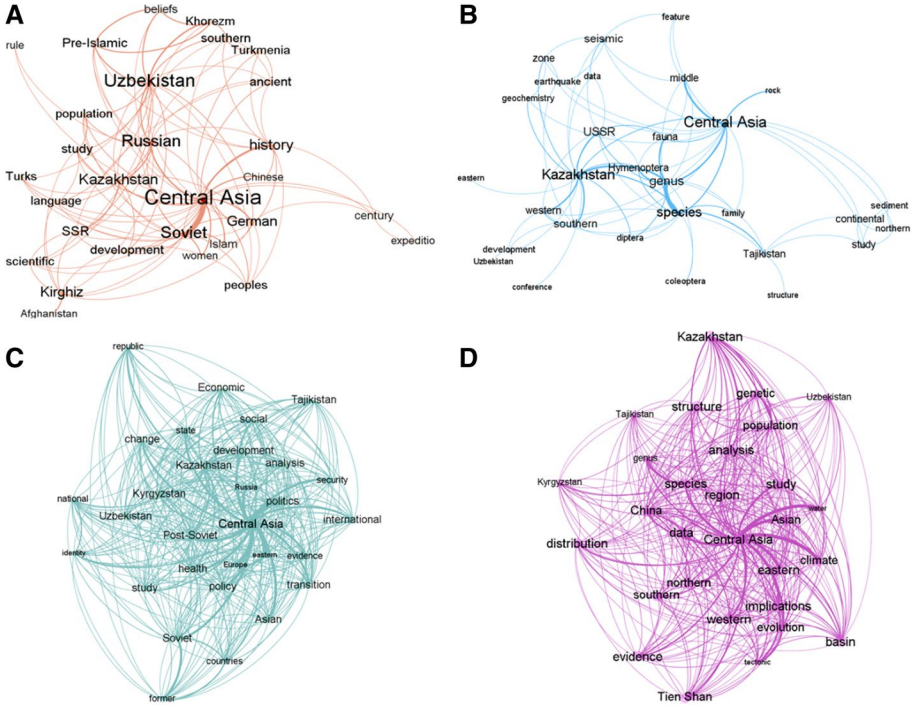

Fig. 5 Mappings of title keywords from the Science Citation Index Expanded (SCIE) and Social Science Citation Index (SSCI) for Central Asia. **a** Co-keyword mapping of the SSCI for Central Asia in 1900–1991. **b** Co-keyword mapping of the SCIE for Central Asia in 1900–1991. **c** Co-keyword mapping of the SSCI for Central Asia in 1992–2016. **d** Co-keyword mapping of the SCIE for Central Asia in 1992–2016

the northeast. Obviously, the topic of "northern" has a relationship with northern Kazakhstan, Tien Shan and the Xinjiang province of China with respect to geology and mineralogy (Selyatitskii et al. 2012; Orozbaev et al. 2011). The eastern area has a relationship with eastern Europe, Tien Shan and the eastern Qinghai–Tibetan Plateau with respect to geology, geochemistry, geophysics and immunology (Wilson et al. 2012; Li et al. 2011; Ferrat et al. 2012). Some new terms, such as "implication", "basin", "genetic", "evolution", "water", "population", "Tien Shan", and "climate", emerged in stage II compared with the title keywords in stage I. Especially, "water" had drew a lot of attention in the studies and the two biggest research areas were water resources (e.g. water security; Jalilov et al. 2013) and environmental sciences (e.g. seasonal variations in water isotopes; Kong et al. 2014).

By comparing title words for SSCI in stage II with those in stage I, many differences can be noticed. First, countries or people of concern in stage I, such as "Soviet", "Russian", "German", "Turks", "SSR", "Chinese", "Kazakhstan", "Uzbekistan", "Kirghiz" and "Afghanistan", reduced in frequency, with only "Post-Soviet", "Soviet", "Russia(n)", "Kazakhstan" and "Uzbekistan" remaining in stage II. Second, the four big themes of "health", "economic", "politics" and "security" drew the public's attention and some problems involved the combination of multiple themes (Peyrouse and Laruelle 2015; Johnson 2014). Researchers focused on "transition", "international", "social" and "eastern" in stage II. "Transition" was most concerned with transitional economies in international relations (Hidi 2012). In terms of "international", the research paid more

attention to foreign policy in international relationships, health and disease prevention policies and security policies (Gould-Davies 2014; Ancker and Rechel 2013; Omelicheva 2009). "Social" problems related to health or a combination of health with environmental and economic issues (Wagstaff and Moreno-Serra 2009). In terms of "eastern", the direction mainly involved the eastern portion of the Xinjiang province of China and the eastern portion of the Tibetan Plateau and relevant studies focused on the environment and geology (Wang et al. 2015).

Institution outputs and directions

Tables 4 and 5 show the top 20 most productive institutions and their most popular research fields in the study of Central Asia in stages I and II. In stage I, almost all of the top 20 most productive institutions came from the USSR and two institutions came from other locations (the Czech Republic and the USA). All other institutions belonged to the former Soviet Union. This result illustrates that before the collapse of the USSR, other countries showed little attention to Central Asian research, while a majority of institutions stemmed from the Soviet Union. In stage II, the former Soviet Union members only comprised one-fourth of the top 20 most productive institutions. The remaining three-fourths were located in China, the USA and Europe. China therefore paid close attention to Central Asian studies and Central Asia received much more research attention from the rest of the world.

Although the research areas of the top 20 institutions in stage II were more diverse than those in stage I, most publications focused on the physical sciences, such as Geology, Environmental Sciences & Ecology, Geochemistry & Geophysics, Paleontology, Zoology and Physical Geography. Among these studies, Geology and Geochemistry & Geophysics received significant attention, notably through the study of earthquakes, geological structures and geochemical processes (Nikiforova et al. 1989; Given et al. 1990; Sevryugin et al. 1990; Trifonov 1978). This is because Central Asia is located on both the Tethys tectonic domain and the paleo-Asian tectonic domain (Yuan-xi 2003; Lü et al. 2017). Environmental Sciences & Ecology became another popular research field after the collapse of the Soviet Union. During Soviet times, agricultural issues were always a contentious issue in the development of the national economy. To resolve the food crisis, Nikita Khrushchev adopted "the most urgent measures" to develop grain production from 1954 to 1960. In these measures, the main method was the large-scale reclamation of cultivated land. Targeted lands included areas on the right bank of the Volga, in northern Kazakhstan, in the northern Caucasus and in Western Siberia. This was the famous "Virgin Lands Campaign" (Miller 1977). However, excessive reclamation of arable land caused many environmental problems. From the late 1950s onwards, reclaimed regions witnessed significant soil degradation, leading to decreased soil organic matter (Josephson et al. 2013). In the spring of 1963, several strong storms swept away hundreds of tons of fertile soil from the Virgin Lands (Kraemer et al. 2015). After the collapse of the Soviet Union, environmental problems worsened, sometimes to a catastrophic level. As a result, more institutions focused on environmental issues in Central Asia.

Zoology publications focused on particular animals (Sergeev and Pokivajlov 1992) and palaeontology (Dodonov et al. 1991). In terms of health, research focused on the type of infection transmission (Adambekov et al. 2016), new viruses (Karamendin et al. 2014) and the influence of weather on disease (Grjibovski et al. 2012).

Table 4 The top 20 most productive institutions in the study of Central Asia in 1900–1991

Rank	Institution	Country	Subject categories	TP	TC	CPP
1	Academy of Science of USSR	USSR	Science & Technology—other topics; Geology; Zoology	238	800	3.36
2	MV Lomonosov State University	USSR	Science & Technology—other topics; Zoology; Geology	75	128	1.71
3	Academy of Science of KASSR (KASSR)	KASSR	Zoology; Geochemistry & Geophysics; Parasitology	52	76	1.46
4	Academy of Science of KASSR (USSR)	USSR	Zoology; Energy & Fuels; Engineering	51	96	1.88
5	Academy of Medical Science of USSR	USSR	Genetics & Heredity; General & Internal Medicine; Pharmacology & Pharmacy	48	214	4.46
6	Academy of Science of TASSR (TASSR)	TASSR	Science & Technology—other topics; Geology; Geochemistry & Geophysics	42	50	1.19
7	Academy of Science of TASSR (USSR)	USSR	Geochemistry & Geophysics; Science & Technology—other topics; Zoology	31	39	1.26
8	Oy Shmidt Earth Phys Institution	USSR	Geology; Science & Technology—other topics;	28	111	3.96
9	Academy of Science of UZSSR (UZSSR)	UZSSR	Geochemistry & Geophysics; Chemistry; Geology	26	54	2.08
10	Academy of Science of UZSSR (USSR)	USSR	Science & Technology—other topics; Chemistry; Geology	22	21	0.95
11	Academy of Science of UKSSR (UKSSR)	UKSSR	Geology; Science & Technology—other topics; Geochemistry & Geophysics	18	8	0.44
12	Academy of Science of KISSR (KISSR)	KISSR	Meteorology & Atmospheric Sciences; Oceanography; Parasitology	17	28	1.65
13	All Union Geol Res institution	USSR	Science & Technology—other topics; Palaeontology; Geology	17	59	3.47
14	Di Ivanovskii Virol Institution	USSR	Virology; Infectious Diseases; General & Internal Medicine	17	57	3.35
15	Academy of Science of TUSSR (TUSSR)	TUSSR	Parasitology; Geochemistry & Geophysics; Geography	13	9	0.69
16	Czechoslovak Academy of Sciences	Czechoslovakia	Entomology; Parasitology; Environmental Sciences & Ecology	13	40	3.08
17	Columbia University	USA	Arts & Humanities—other topics; Ethnic Studies; Geology	12	136	11.33
18	Oy Shmidt Geophys institution	USSR	Geology; Science & Technology—other topics; Geochemistry & Geophysics	12	30	2.50
19	AA Zhdanov State University	USSR	Science & Technology—other topics; Geochemistry & Geophysics; Palaeontology	11	21	1.91
20	Academy of Science of KISSR (USSR)	USSR	Geochemistry & Geophysics; Geology; Palaeontology	11	55	5.00

TP total publications, *TC* the total citation count, *CPP* the average number of citations per publication

Table 5 The top 20 most productive institutions in the study of Central Asia in 1992–2016

Rank	Research institute	Country	Subject categories	TP	TC	CPP
1	Russian Academy of Science	Russia	Geology; Palaeontology; Geochemistry & Geophysics	1793	27,033	15.08
2	Chinese Academy of Sciences	China	Geology; Environmental Sciences & Ecology; Physical Geography	1004	28,502	28.39
3	Moscow MV Lomonosov State University	Russia	Zoology; Geology; Geochemistry & Geophysics	301	2823	9.38
4	Peking University	China	Geology; Geochemistry & Geophysics; Physical Geography	158	6591	41.72
5	Lanzhou University	China	Geology; Physical Geography; Environmental Sciences & Ecology	157	3401	21.66
6	Chinese Academy Geological Sciences	China	Geology; Geochemistry & Geophysics; Mineralogy	153	7119	46.53
7	Xinjiang Medical University	China	Cardiovascular System & Cardiology; Oncology; Biochemistry & Molecular Biology	153	1444	9.44
8	Uzbek Academy of Science	Uzbekistan	Chemistry; Pharmacology & Pharmacy; Astronomy & Astrophysics	150	2624	17.49
9	China University of Geosciences	China	Geology; Geochemistry & Geophysics; Mineralogy	134	3152	23.52
10	Al-Farabi Kazakh National University	Kazakhstan	Chemistry; Environmental Sciences & Ecology; Psychology	120	407	3.39
11	Columbia University	USA	Geochemistry & Geophysics; Public, Environmental & Occupational Health; Substance Abuse	115	2430	21.13
12	University of Bonn	Germany	Agriculture; Environmental Sciences & Ecology; Water Resources	109	2140	19.63
13	Saint Petersburg State University	Russia	Geology; Palaeontology; Mineralogy	106	1400	13.21
14	Nanjing University	China	Geology; Geochemistry & Geophysics; Meteorology & Atmospheric Sciences	103	4239	41.16
15	Stanford University	USA	Geology; Geochemistry & Geophysics; Mineralogy	98	6496	66.29
16	University of Chinese Academy Sciences	China	Geology; Environmental Sciences & Ecology; Physical Geography	98	756	7.71
17	Free University of Berlin	Germany	Geology; Physical Geography; Palaeontology	97	1660	17.11
18	Natural History Museum	UK	Geology; Palaeontology; Zoology	95	3889	40.94
19	Shihezi University	China	Biochemistry & Molecular Biology; Genetics & Heredity; Oncology	92	791	8.60
20	University of Oxford	UK	Geochemistry & Geophysics; Geology; Environmental Sciences & Ecology	89	4005	45.00

TP total publications, *TC* the total citation count, *CPP* the average number of citations per publication

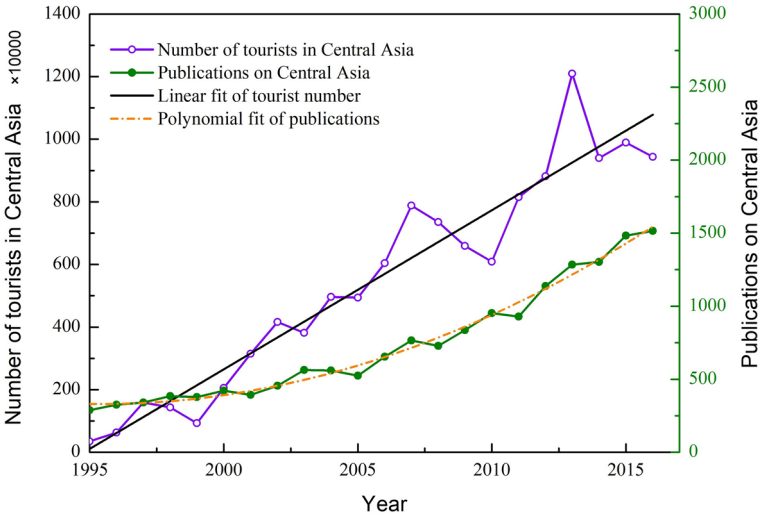

Fig. 6 Relationship between publications on Central Asia and the number of tourists in Central Asia

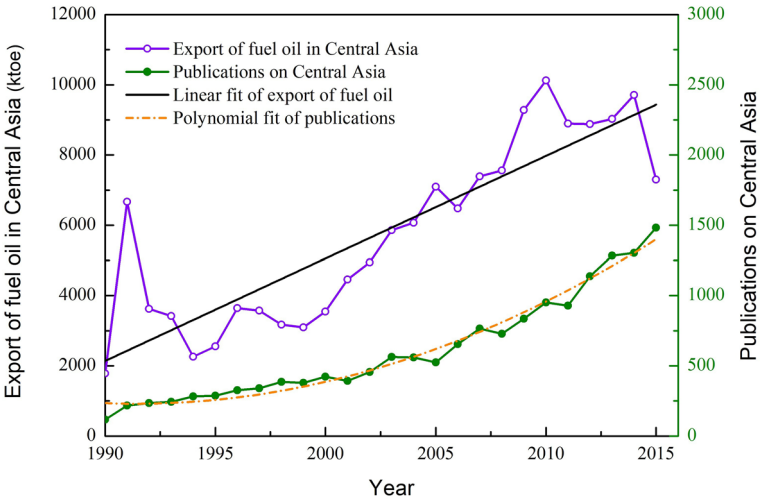

Fig. 7 Relationship between publications on Central Asia and exports of fuel oil in Central Asia

The relationship between global Central Asian research outputs and relevant impact factors

We found that the cumulative number of global Central Asia studies increased with the number of tourists, exports of fuel oil and GDP (Figs. 6, 7 and 8). Research publications can be quantified by a quadratic polynomial model $y = 0.79x^2 - 3109.47x + 3.07 \times 10^6$ ($R^2 = 0.955$), where x and y denote time and the number of publications, respectively. We found that the number of tourists and exports of fuel oil had linear fits with year, while

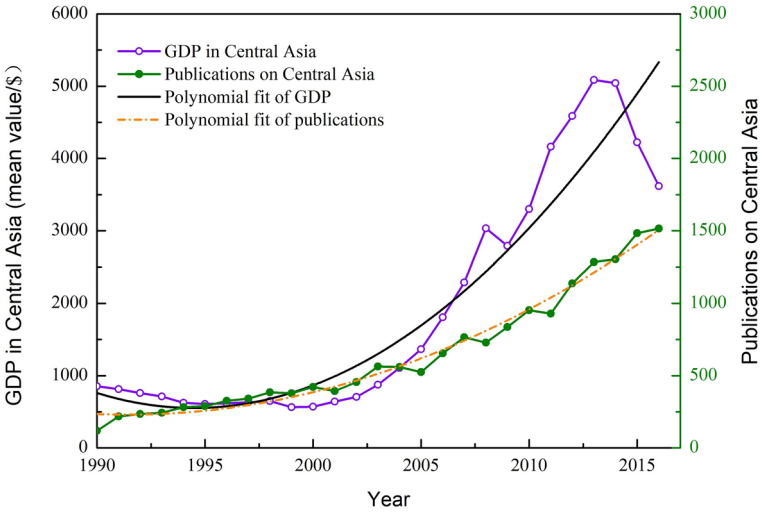

Fig. 8 Relationship between publications on Central Asia and gross domestic product (GDP) in Central Asia

GDP had a polynomial fit. Table 6 summarizes the correlations between the number of publications on Central Asia and the number of tourists, exports of fuel oil and GDP in Central Asia. The correlation between publications and GDP had the highest correlation coefficient (0.923) followed by the number of tourists (0.917) and exports of fuel oil (0.831). These results reflect the close relationship between scholarly outputs on Central Asia and the number of tourists, exports of fuel oil and GDP in Central Asia.

Central Asia has important research value, as there are many tourism resources due to the region's geographical location, natural splendour, historical architecture and exotic culture. The region includes the "Ancient Silk Road" and it has attracted large numbers of scholars. Before the collapse of the USSR, tourism had not been as prosperous as in other regions due to multiple reasons. The region was still very turbulent and unstable because of surrounding wars, civil commotions, separatism and terrorism. Underdeveloped transportation, connectivity and infrastructure were unfavourable factors for tourism growth (Koh and Kwok 2017). Until the middle of the 1950s, most tourist facilities in the USSR only catered for domestic tourists (Hall 1991). During the Soviet period, sanatoria were the most popular places for domestic visitors and other forms of tourism were not prevalent. By contrast, foreign tourists were interested in culture, historical sites and the development of the USSR.

Table 6 Equations and coefficients of determination between publications and the number of tourists, exports of fuel oil and gross domestic product (GDP)

Type	Factors	Equations	R^2	Correlation coefficient
Linear fit	Number of tourists	$y = 50.82x - 1.01 \times 10^5$	0.919	0.917
	Exports of fuel oil	$y = 291.75x - 5.78 \times 10^5$	0.733	0.831
Polynomial fit	GDP	$y = 10.33x^2 - 4.12 \times 10^4 x + 4.11 \times 10^7$	0.878	0.923

With the dissolution of the Soviet Union in 1991, the Cold War ended and the tourism industry changed significantly. Each independent country in Central Asia has positively adapted to changes in the fast-paced global tourism market and each seeks its individual path in the tourism industry (Werner 2003). The collapse of the USSR also prompted more and more people to research Central Asia and the number of publications increased.

Kyrgyzstan is nestled between China, Kazakhstan, Uzbekistan and Tajikistan and is called the "Switzerland of Asia". The country is well known for its unique natural scenery and rich history as well as distinctive and historic tourist attractions, such as the Issyk-Kul Lake and the Burana Tower. Furthermore, Kyrgyzstan's government made good headway in developing tourism, including improving tourism facilities, increasing transportation input and optimizing tourist visa procedures. All of these initiatives are regarded as very helpful factors for the tourism community (Kantarci 2007). Hence, Kyrgyzstan has become a hotspot for research in recent years.

Exports of fuel oil have a close relationship with global research outputs on Central Asia. Most of the publications focused on specialized knowledge on fuel oil in Central Asia (Karabaev et al. 2013), the cooperation between Central Asia and other countries in oil and gas (Kalyuzhnova and Lee 2014) and the impact of changes in international oil prices on local economies. Central Asian countries are well known for their abundant natural resources. Kazakhstan is endowed with significant oil and gas resources. The country is ranked 11th in the world in terms of proven crude oil reserves and it is the second largest oil producer among the former Soviet Republics behind Russia. Turkmenistan and Uzbekistan also possess extensive natural resources, in particular, natural gas. In the current geo-economic environment, the economies of developed and developing countries depend on the consumption of large amounts of resources. Thus, untapped energy reserves in Central Asia cannot be ignored (Dorian 2006).

Through nearly a century of construction and development, the oil industry of the former Soviet Union became a large and unified industrial system. After the disintegration of the Soviet Union, huge industrial systems were segmented, significantly affecting the industrial development of the Commonwealth of Independence States (CIS) countries. Such a huge change had become a hotspot for many economists to research. The economies of these countries have been subject to great transformations. At the beginning of the transition stage, a deep collapse in production was followed by a recovery in the late 1990s. Central Asian oil exporters developed the oil mining industry and signed oil contracts with global oil companies to increase their share of the international energy market (Hasanov et al. 2016, 2017). The development of the oil sector benefited Kazakhstan' economy and the revenue from the oil sector accounted for an increasing proportion of the total export value of the country from 2001 to 2014.

However, due to the oil price shocks of 2014, oil-exporting countries experienced substantial economic recessions. These countries had to pay extensive attention again to the rest of the world (Bayramov and Abbas 2017). Some researchers dedicated themselves to the study of the influence of oil price shocks on oil exporters in Central Asia and some scholars researched diversification policies and subsidized economies in these countries. The most striking example was Kazakhstan. Because more than 50% of the country's total quantum of trade was from oil exports, the oil price changes made Kazakhstan's domestic financial situation more serious and challenging for economic growth (Elmira et al. 2017). Thus, oil shocks made Central Asian oil-exporting countries recognize their deficiencies in terms of their own economic development. It also helped them seek appropriate measures and learn from others to develop their domestic economies.

Global publications on Central Asia were also intimately related to the GDP of these countries. The majority of papers related to GDP focused on economic development, economic systems, industrial structure, individual incomes, the human development index and investments abroad. Before the collapse of the USSR, the former Soviet Union developed massive constructions of socialist industries. There was a high degree of national economic integration. In the middle of the 1970s, the Soviet Union became one of the world's top powers with respect to economics, politics and the military. Thus, more and more scholars researched the USSR's economic system and its economic efficiency and industrial structure (Krasovskii and Fridman 1986; Ivashkin 1986). However, the highly centralized economic management system restricted interior economic development. Available funds were not evenly distributed and this caused civilian production in the Soviet Union to lag behind that of other countries for a long period.

The expansion of the military-industrial sector in the former Soviet Union was beyond the capacity of the national economy. Military spending reached 155 billion Rupees in 1981, which accounted for one-third of the total expenditure of national revenue. Huge military costs aggravated the burden on the national economy at the time and drew scholars' attention to economic systems, economic returns and military investment (Allen 1984; Leitenberg 1979). After the dissolution of the Soviet Union, economic systems and operation mechanisms in the five Central Asian countries changed substantially (Kuboniwa 1998; O'hara 1997). International research on central Asia entered a new era.

Although these countries have many common socio-economic features, they adopted different approaches to transitioning to a market economy. Kyrgyzstan conducted a series of reforms on land and farmers eventually came in possession of their own land (Lerman 2008). Other countries, such as Uzbekistan, Turkmenistan and Tajikistan, continued to use pseudo-Soviet agricultural policies (Csaki et al. 2004; Djanibekov and Finger 2018). At the same time, for the sake of seeking new economic and commercial patterns, governments decided to carry more international trade cooperation in certain fields, such as minerals, crude oil and natural gas (Gleason 2003; Stone 1995; Blazyca 2004). Since the revenue from energy resources accounted for a large proportion of Central Asia's GDP, many studies on energy exports were conducted.

The development of the hydrocarbons sector played a vital role in Kazakhstan. Over the past two decades, there has been a dramatic change to Kazakh economic development in the oil and gas sector. In the 1990s, Kazakhstan encountered many difficulties in developing a domestic economy. Following a substantial increase in oil prices, Kazakhstan experienced rapid economic growth from 1999 onwards (Kalyuzhnova and Patterson 2016). The country showed an average growth of 6.5% in GDP from 2010 to 2013. However, as a country depending on oil exports to stimulate national economic development, international oil price changes had a large impact on the national economy. Kazakhstan suffered a prominent economic slowdown because of the shock of international oil prices. GDP growth declined to 4.1% in 2014 and then rose by only 1.2% in 2015 (Bayramov and Abbas 2017; World Bank 2015a). Meanwhile, the economic structure of Kazakhstan remains poorly diversified. Research on oil exporters in Central Asia remains important since these countries have a direct influence on the international oil market.

Conclusion

We evaluated the differences in global research on Central Asia before and after the collapse of the USSR from 1900 to 2016 with statistical analyses and analysed the relationship between global Central Asia research outputs and the number of tourists, exports of fuel oil and GDP.

From 1964 to 1991, total publications on Central Asia showed high growth trends with an average annual growth rate of 6.73% compared to the total publication growth rate of the SCIE and SSCI (4.91%). Contributions mainly stemmed from publications on Central Asia in the SCIE. The period 1992–2016 experienced a meteoric growth of Central Asia research and the total number of publications on Central Asia showed an average annual growth rate of 6.15%. The SCIE played a dominant role in the increase in research on Central Asia during the period.

Comparing subject categories in 1900–1991 and 1992–2016, Geology and Environmental Science & Ecology showed the most robust increases. The subject categories of Science & Technology—Other Topics, Geography and Anthropology, which ranked in the top six in 1900–1991, sharply decreased in 1992–2016. Parasitology, Chemistry, History, Infectious Diseases, General & Internal Medicine and Entomology appeared in the top 20 rankings in 1900–1991 but disappeared from the top 20 in 1992–2016. International Relations, Public, Environmental & Occupational Health, Meteorology & Atmospheric Sciences, Mineralogy and Water Resources entered the top 20 rankings in 1992–2016.

The USSR (880 publications), the USA (222) and KASSR (112) were the three most productive countries in 1900–1991. In 1992–2016, the top three productive countries were the USA (3488 publications), Russia (3155) and China (2337). Research countries became more diverse between 1900–1991 and 1992–2016 and more publications originated from international collaborations. Major collaborators also became more diverse in 1992–2016 and included Russia, the USA and China, among others. On the other hand, collaborating countries mostly came from the former Soviet Union in 1900–1991.

We found the following differences when comparing title keywords for the SCIE for the two time periods. First, countries of concern to the USSR and SSR in 1900–1991 changed to China and the five Central Asian countries. Second, the ranking order of the orientation nouns “southern”, “western”, “northern”, and “eastern” in 1900–1991 changed to “northern”, “eastern”, “western”, and “southern” in 1992–2016. Third, some new title keywords, such as “implication”, “basin”, “genetic”, “evolution”, “water”, “population”, “Tien Shan” and “climate”, emerged in 1992–2016. We also found differences between time periods when comparing title keywords for the SSCI. Countries became less diverse and only “Post-Soviet”, “Soviet”, “Russia(n)”, “Kazakhstan” and “Uzbekistan” remained in 1992–2016. The four big themes of “health”, “economic”, “politics” and “security” drew the public’s attention and some problems combined more than one aspect. Research also focused on “transition”, “international”, “social” and “eastern” in 1992–2016.

Comparing institution productivity between the two time periods, China started to pay close attention to Central Asian studies and Central Asia received much more attention from the rest of the world. Although the research areas of the top 20 institutions in 1992–2016 were more diverse compared to those in 1900–1991, most publications focused on physical sciences.

We also investigated the relationship between Central Asia research and the number of tourists, exports of fuel oil and GDP in Central Asia. The number of tourists and the exports of fuel oil had linear fits with year, while GDP had a polynomial fit. All the

correlation coefficients between publication numbers and explanatory factors were high. These results reflect the close relationship between scholarly outputs for a range of topics and the number of tourists, exports of fuel oil and GDP in Central Asia.

References

Abramo, G., D'Angelo, C. A., & Viel, F. (2011). The field-standardized average impact of national research systems compared to world average: The case of Italy. *Scientometrics, 88*(2), 599–615.

Adambekov, S., Kaiyrlykyzy, A., Igissinov, N., & Linkov, F. (2016). Health challenges in Kazakhstan and Central Asia. *Journal of Epidemiology and Community Health, 70*(1), 104–108.

Alamanov, A., & Mikkola, H. (2011). Is biodiversity friendly fisheries management possible on Issyk-Kul Lake in the Kyrgyz Republic? *Ambio, 40*(5), 479.

Allen, G. (1984). Prospects for Soviet agricultural production and trade: By Ad Hoc group on east/west economic relations, committee for agriculture OECD, Paris, 1983. *Food Policy, 9*(2), 172–174.

An, C. B., Lu, Y., Zhao, J., Tao, S., Dong, W., Li, H., et al. (2012). A high-resolution record of Holocene environmental and climatic changes from Lake Balikun (Xinjiang, China): Implications for central Asia. *The Holocene, 22*(1), 43–52.

Ancker, S., & Rechel, B. (2013). HIV/AIDS policy-making in Kyrgyzstan: A stakeholder analysis. *Health Policy and Planning, 30*(1), 8–18.

Bayramov, V., & Abbas, G. (2017). Oil shock in the Caspian Basin: Diversification policy and subsidized economies. *Resources Policy, 54,* 149–156.

Blazyca, G. (2004). Building capitalism: The transformation of the former soviet bloc. *Economics of Transition, 12*(1), 191–192.

Chen, S. R., Chiu, W. T., & Ho, Y. S. (2005). Asthma in children: Mapping the literature by bibliometric analysis. *Revue francaise d'allergologie et d'immunologie clinique, 45*(6), 442–446.

Chlachula, J. (2010). Pleistocene climate change, natural environments and Palaeolithic occupation of East Kazakhstan. *Quaternary International, 220*(1–2), 64–87.

Choi, S. (2011). Core-periphery, new clusters, or rising stars?: International scientific collaboration among 'advanced' countries in the era of globalization. *Scientometrics, 90*(1), 25–41.

Costa Buranelli, F. (2018). Spheres of influence as negotiated hegemony-the case of Central Asia. *Geopolitics, 23*(2), 378–403.

Csaki, C., Kray, H., & Zorya, S. (2004). *The agrarian economies of Central-Eastern Europe and the commonwealth of independent states: An update on status and progress in 2003*. Washington, DC: World Bank.

Devkota, K. P., Manschadi, A. M., Lamers, J. P. A., Humphreys, E., Devkota, M., Egamberdiev, O., et al. (2013). Growth and yield of rice (*Oryza sativa* L.) under resource conservation technologies in the irrigated drylands of Central Asia. *Field Crops Research, 149,* 115–126.

Djanibekov, U., & Finger, R. (2018). Agricultural risks and farm land consolidation process in transition countries: The case of cotton production in Uzbekistan. *Agricultural Systems, 164,* 223–235.

Dodonov, A., Zhegalo, V., Penkov, A., & Sotnikova, M. V. (1991). Stratigraphy of the late pliocene vertebrates occurrences in southern tajikistan. *Izvestiya akademii nauk sssr seriya geologicheskaya, 5,* 12–21.

Dorian, J. P. (2006). Central Asia: A major emerging energy player in the 21st century. *Energy Policy, 34*(5), 544–555.

Elmira, B., Feng, J. W., & Xiao-Ling, W. (2017). Analysis on the impact of international oil price changes on Kazakhstan's economy. *DEStech Transactions on Economics, Business and Management*, (2017 International Conference on Economics, Management Engineering and Marketing).

Ferrat, M., Weiss, D. J., Spiro, B., & Large, D. (2012). The inorganic geochemistry of a peat deposit on the eastern Qinghai–Tibetan plateau and insights into changing atmospheric circulation in central Asia during the Holocene. *Geochimica et Cosmochimica Acta, 91,* 7–31.

Given, H. K., Tarasov, N. T., Zhuravlev, V., Vernon, F. L., Berger, J., & Nersesov, I. L. (1990). High-frequency seismic observations in eastern Kazakhstan, USSR, with emphasis on chemical explosion experiments. *Journal of Geophysical Research: Solid Earth, 95*(B1), 295–307.

Gleason, G. (2003). *Markets and politics in Central Asia* (Vol. 2). London: Routledge.

Gould-Davies, N. (2014). US foreign policy in the Caucasus and Central Asia: Politics, energy and security. *International Affairs, 90*(6), 1488–1489.

Grjibovski, A., Nurgaliyeva, N., Kosbayeva, A., & Menne, B. (2012). No association between temperature and deaths from cardiovascular and cerebrovascular diseases during the cold season in Astana, Kazakhstan—The second coldest capital in the world. *International Journal of Circumpolar Health, 71*(1), 19769.

Hall, D. R. (1991). *Tourism & economic development in Eastern Europe & the Soviet Union*. London: Belhaven Press.

Hanks, R. R. (2009). 'Multi-vector politics' and Kazakhstan's emerging role as a geo-strategic player in Central Asia. *Journal of Balkan and Near Eastern Studies, 11*(3), 257–267.

Hasanov, F. J., Hunt, L. C., & Mikayilov, C. I. (2016). Modeling and forecasting electricity demand in Azerbaijan using cointegration techniques. *Energies, 9*(12), 1045.

Hasanov, F., Mikayilov, J., Bulut, C., Suleymanov, E., & Aliyev, F. (2017). The role of oil prices in exchange rate movements: The CIS oil exporters. *Economies, 5*(2), 13.

Hidi, Á. (2012). Transition economies: Political economy in Russia, Eastern Europe, and Central Asia. *Acta Oeconomica, 62*(3), 407–413.

Howard-Johnston, J. (2013). Central Asia in world history, by Peter B. Golden. *English Historical Review, 128*(532), 641–642.

Hsieh, W. H., Chiu, W. T., Lee, Y. S., & Ho, Y. S. (2004). Bibliometric analysis of patent ductus arteriosus treatments. *Scientometrics, 60*(2), 105–215.

Ivashkin, S. (1986). The history of the change of animal husbandry in the ussr to an industrial basis (1960–1985). *Voprosy Istorii, 10,* 20–32.

Jalilov, S. M., Amer, S. A., & Ward, F. A. (2013). Water, food, and energy security: An elusive search for balance in central Asia. *Water Resources Management, 27*(11), 3959–3979.

Johnson, E. (2014). Non-state health care provision in Kazakhstan and Uzbekistan: Is politicisation a model? *Europe-Asia Studies, 66*(5), 735–758.

Jolley, E., Rhodes, T., Platt, L., Hope, V., Latypov, A., Donoghoe, M., et al. (2012). HIV among people who inject drugs in Central and Eastern Europe and Central Asia: A systematic review with implications for policy. *British Medical Journal Open, 2*(5), e001465.

Josephson, P., Dronin, N., Mnatsakanian, R., Cherp, A., Efremenko, D., & Larin, V. (2013). *An environmental history of Russia*. Cambridge: Cambridge University Press.

Kalyuzhnova, Y., & Lee, J. (2014). China and Kazakhstan's oil and gas partnership at the start of the twenty-first century. *Emerging Markets Finance and Trade, 50*(5), 206–221.

Kalyuzhnova, Y., & Patterson, K. (2016). Kazakhstan: Long-term economic growth and the role of the oil sector. *Comparative Economic Studies, 58*(1), 93–118.

Kantarci, K. (2007). The image of Central Asia countries: Kyrgyzstan, Kazakhstan, Uzbekistan, and Turkmenistan. *Tourism Analysis, 12*(4), 307–318.

Karabaev, Z. A., Kapustin, V. M., Tanashev, S. T., Sakibaeva, S. A., Iskendirov, B. Z., & Bimbetova, G. Z. (2013). Intensification of vacuum distillation of residual fuel oil from Kumkol Oil by controlling phase transitions of oil disperse systems. *Chemistry and Technology of Fuels and Oils, 49*(3), 239–244.

Karamendin, K., Kydyrmanov, A., Kasymbekov, Y., Khan, E., Daulbayeva, K., Asanova, S., et al. (2014). Continuing evolution of equine influenza virus in Central Asia, 2007–2012. *Archives of Virology, 159*(9), 2321–2327.

Koh, S. G., & Kwok, A. O. (2017). Regional integration in Central Asia: Rediscovering the silk road. *Tourism Management Perspectives, 22,* 64–66.

Kong, Y., Pang, Z., Li, J., & Huang, T. (2014). Seasonal variations of water isotopes in the Kumalak river catchments, Western Tianshan Mountains, Central Asia. *Fresenius Environmental Bulletin, 23*(1), 169–174.

Kraemer, R., Prishchepov, A. V., Müller, D., Kuemmerle, T., Radeloff, V. C., Dara, A., et al. (2015). Long-term agricultural land-cover change and potential for cropland expansion in the former Virgin Lands area of Kazakhstan. *Environmental Research Letters, 10*(5), 054012.

Krasovskii, V., & Fridman, L. (1986). Accumulation and technical progress in the USSR economy. *Problems in Economics, 28*(11), 3–18.

Kuboniwa, M. (1998). National income in postwar Central Asia. *Hitotsubashi Journal of Economics, 39*(2), 67–100.

Leitenberg, M. (1979). The counterpart of defense industry conversion in the United States: The USSR economy, defense industry, and military expenditure—An introduction and guide to sources. *Journal of Peace Research, 16*(3), 263–277.

Lerman, Z. (2008). Agricultural development in Central Asia: A survey of Uzbekistan, 2007–2008. *Eurasian Geography and Economics, 49*(4), 481–505.

Li, Z., Li, H., & Chen, Y. (2011). Mechanisms and simulation of accelerated shrinkage of continental glaciers: A case study of Urumqi Glacier No. 1 in eastern Tianshan, central Asia. *Journal of Earth Science, 22*(4), 423–430.

Li, Y., Smith, T., Svetlana, P., Yang, J., Jin, J. H., & Li, C. S. (2014). Paleobiogeography of the lotus plant (Nelumbonaceae: Nelumbo) and its bearing on the paleoclimatic changes. *Palaeogeography, Palaeoclimatology, Palaeoecology, 399,* 284–293.

Lü, B., Wang, T., Tong, Y., et al. (2017). Spatial & temporal distribution and tectonic settings of magmatic-hydrothermal ore deposits in the Eastern Central Asia Orogen belt. *Journal of Jilin University (Earth Science Edition), 47*(2), 305–343.

Miller, M. (1977). Khrushchev and the development of soviet agriculture: The virgin land programme 1953–1964. *International Affairs, 53*(3), 498–499.

Nikiforova, N. N., Yudakhin, F. N., & Toktosopiev, A. M. (1989). Studies of electromagnetic emission of seismotectonic origin in the Kirghiz SSR. *Physics of the Earth and Planetary Interiors, 57*(1–2), 68–75.

O'hara, S. L. (1997). Agriculture and land reform in Turkmenistan since independence. *Post-Soviet Geography & Economics, 38*(7), 430–444.

Omelicheva, M. Y. (2009). Convergence of counterterrorism policies: A case study of Kyrgyzstan and Central Asia. *Studies in Conflict & Terrorism, 32*(10), 893–908.

Orozbaev, R. T., Yoshida, K., Bakirov, A. B., Hirajima, T., Takasu, A., Sakiev, K. S., et al. (2011). Preiswerkite and högbomite within garnets of Aktyuz eclogite, Northern Tien Shan, Kyrgyzstan. *Journal of Mineralogical and Petrological Sciences, 106*(6), 320–325.

Peyrouse, S., & Laruelle, M. (2015). *Globalizing Central Asia: Geopolitics and the challenges of economic development*. Abingdon: Routledge.

Rahaman, M. M. (2012). Principles of transboundary water resources management and water-related agreements in Central Asia: An analysis. *International Journal of Water Resources Development, 28*(3), 475–491.

Selyatitskii, A. Y., Kuz'Min, D. V., & Sobolev, N. V. (2012). Minor elements in unusual olivines from high-pressure peridotites of the kokchetav massif (northern kazakhstan). *Doklady Earth Sciences, 445*(2), 1015–1020.

Sergeev, M., & Pokivajlov, A. (1992). New and little known orthopterans from Tadjikistan. *Zoologichesky zhurnal, 71*(3), 137–142.

Sevryugin, N. N., Fedorenko, O. A., Doludenko, M. P., Kirichkova, A. I., & Sakulina, G. V. (1990). The jurassic sediments of karatau ridge (southern kazakhstan). *Izvestiya akademii nauk sssr seriya geologicheskaya, 7,* 63–77.

Stone, R. (1995). How Russia became a market economy. *Political Science Quarterly, 110*(4), 666–668.

Terraube, J., Arroyo, B. E., Mougeot, F., Katzner, T. E., & Bragin, E. A. (2010). Breeding biology of Montagu's Harrier Circus pygargus in north-central Kazakhstan. *Journal of Ornithology, 151*(3), 713–722.

Trifonov, V. G. (1978). Late quaternary tectonic movements of western and central Asia. *Geological Society of America Bulletin, 89*(7), 1059–1072.

Wagstaff, A., & Moreno-Serra, R. (2009). Europe and central Asia's great post-communist social health insurance experiment: Aggregate impacts on health sector outcomes. *Journal of Health Economics, 28*(2), 322–340.

Wang, P., Li, Z., Zhou, P., Wang, W., Jin, S., Li, H., et al. (2015). Recent changes of two selected glaciers in Hami prefecture of eastern Xinjiang and their impact on water resources. *Quaternary International, 358,* 146–152.

Wang, M. H., Yu, T. C., & Ho, Y. S. (2009). A bibliometric analysis of the performance of water research. *Scientometrics, 84*(3), 813–820.

Weeks, T. R. (2004). The overturning revolution: Central Asia between the collapse of the Tsarist empire and the formation of the URSS. *Slavic Review, 63*(4), 876–877.

Werner, C. (2003). The new silk road: Mediators and tourism development in Central Asia. *Ethnology, 42*(2), 141–161.

Wilson, D., Zhang, L., Kerr, C., Kwon, A., Hoare, A., Williams-Sherlock, M., et al. (2012). The cost-effectiveness of needle-syringe exchange programs in Eastern Europe and Central Asia: Costing, data synthesis, modeling and economics for eight case study countries. *Journal of the International Aids Society, 15,* 150–151.

World Bank. (2015a). Kazakhstan: Low oil prices, an opportunity to reform. World Bank Group, Economic update no 1. Retrieved from: http://www.worldbank.org/en/country/kazakhstan/publication/kazakhstan-economic-updatespring-2015. Accessed 3 Aug 2017.

Xiao, W., Han, C., Yuan, C., Sun, M., Lin, S., Chen, H., et al. (2008). Middle Cambrian to Permian subduction-related accretionary orogenesis of Northern Xinjiang, NW China: Implications for the tectonic evolution of central Asia. *Journal of Asian Earth Sciences, 32*(2–4), 102–117.

Yuan-Xi, Q. I. U. (2003). Tethyan tectonic belt and global latitudinal tectonic system. *Journal of Geomechanics, 3,* 003.

Zakhirova, L. (2013). The international politics of water security in Central Asia. *Europe-Asia Studies, 65*(10), 1994–2013.

Zhang, K. J. (2012). Destruction of the North China Craton: Lithosphere folding-induced removal of lithospheric mantle? *Journal of Geodynamics, 53,* 8–17.

Zhang, Z., Abuduwaili, J., & Jiang, F. (2013). Determination of occurrence characteristics of heavy metals in soil and water environments in Tianshan mountains, Central Asia. *Analytical Letters, 46*(13), 2122–2131.

Zhuang, Y., Du, C., Zhang, L., Du, Y., & Li, S. (2015). Research trends and hotspots in soil erosion from 1932 to 2013: A literature review. *Scientometrics, 105*(2), 743–758.

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