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IS THERE INTEREST IN GREEN DEAL RESEARCH IN CENTRAL ASIA?

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ABSTRACT. Research activities play a critical role in facilitating growth and promoting sustainable development. However, the scientific interest level in the European Green Deal in Central Asia remains uncertain. Therefore, this research paper aims to define the interest of Central Asian researchers in the Green Deal. A literature review was conducted using the bibliographic analysis method for Web of Science publications published over 2018-2023 and originating from Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan. Co-occurrence analysis of keywords and co-authorship analysis were performed using the VosViewer 1.6.19 software. The co-occurrence analysis revealed that the Green Deal is a complex and interdisciplinary issue that highlights the importance of collaboration among stakeholders and researchers from different sectors. The co-authorship analysis identified the patterns of collaboration among authors, with many working with international partners. The distribution of publications and citations varied across different countries and keywords related to environmental and sustainability topics. It was also found that the number of publications has been increasing. Finally, correlation and regression analysis were applied to identify the factors that influence publication activity about the Green Deal.

JEL Classification: M00, H70, I25, O15

Keywords: green deal, climate change, R&D, human capital management

Introduction

Climate change is a crucial challenge that impacts all aspects of people's lives. The whole world is facing this problem and the existential threat of a rising crisis of energy deficit. The Paris Agreement is a universal legally binding global climate change agreement adopted in December 2015 that establishes a global framework to avoid high-risk climate change. This agreement also strives to enable countries' ability to tackle the impacts of climate change and support them in their efforts. As a global issue, climate change requires countries worldwide to work collaboratively. Greenhouse gas emissions all over the world have to be reduced by 43% by 2030 according to the sixth Intergovernmental Panel on Climate Change report (2022). The energy sector is the key point to tackle, as it is the sector with the largest greenhouse gas emissions.

The second and no less important policy regulating climate issues is the European Green Deal presented in 2019. It is the EU's new policy for sustainable development which aims to protect citizens from environmental harms and impacts. The main goals of the Green Deal are achieving a net carbon-neutral European Union by 2050 and maintaining economic growth. Specifically, the Green Deal policy aims to promote supplying clean, affordable, secure energy, implementing a clean and circular economy, limiting pollution of the environment, maintaining biodiversity, and producing healthy environmentally-friendly food. The Green Deal is not only an EU initiative.

Central Asian countries share a common 70-year socialist history as part of the former Soviet Union (USSR). Following the dissolution of the USSR in 1991, these 15 newly formed nations embarked on their independent developmental trajectories. Central Asia, strategically located at the crossroads of Asia and Europe, is gaining increasing geopolitical significance. Abundant in minerals and hydrocarbons, it serves as a major transit zone, supplying the global economy with vital resources such as oil, gas, coal, metals, and agricultural products. The prospect of transitioning to a "green" economy offers the region an opportunity to address its water and energy challenges while fulfilling international commitments. Central Asian countries ratified the Paris Agreement (2015) on climate action in 2019 (UNESCO, 2021).

Central Asian countries collectively account for 0.15% of the global GDP. The highest GDP and GDP per capita are attributed to Kazakhstan, with figures of $220.6 billion and $11,244, respectively. The population of Central Asian countries totals 78.5 million people, representing 1% of the global population.

According to the Global Innovation Index 2022 (Table 1), Central Asian countries (excluding Turkmenistan, which is not included in the ranking) rank below the 80th position out of 132 countries. Uzbekistan leads among the Central Asian countries, ranking 82nd. Kazakhstan occupies the 83rd position among the 132 economies, Kyrgyzstan ranks 94th, and Tajikistan is in the 104th place. Central Asian countries hold low positions in indicators such as gross expenditure on research and development (R&D) as a percentage of GDP and the ratio of scientific and technical articles per billion US dollars of GDP at purchasing power parity (PPP). Uzbekistan excels in the Global Innovation Index in terms of the proportion of graduates in natural and engineering sciences, ranking 6th out of 132 countries. Kazakhstan boasts the highest tertiary education enrollment rates among Central Asian countries. Central Asian countries also have low rankings in the H-index citation indicator.

Table 1. Indicators of Central Asian countries GII

Indicator	KZ	UZB	TJK	KGZ	TKM
Tertiary enrolment, % gross	33	68	84	68	
Gross expenditure on R&D, % GDP	101	98	107	106	
Researchers, FTE/mn pop.	62	73	n/a	n/a	
Global corporate R&D investors, top 3, mln USD	38	38	38	38	
QS university ranking, top 3*	36	72	72	72	
Graduates in science and engineering, %	43	6	56	77	
Scientific and technical articles/bn PPP$ GDP	117	124	116	98	
Citable documents H-index	93	113	129	116	
Subfactor					
Human capital and research	60	65	85	63	
Knowledge and technology outputs	81	80	84	92	
GDP (current US$) 2022	220 623	80391,85	10492,12	10930,64	45610,57
GDP per capita (current US$) 2022	11243,7	2255,2	1054,2	1606,7	7297,2
Population, total	19,621.97	35,648.10	9,952.79	6,803.30	6,430.77

Source: *own compilation*

Central Asia (CA) is highly susceptible to the impacts of climate change, affecting the livelihoods of 72 million individuals, primarily in rural areas. Agriculture is a major component of the region's economy, and the consequences of climate change pose a significant threat to food security and resilience. The region is also facing serious challenges related to water resources, biodiversity preservation, and security. The Central Asian countries have submitted their Nationally Determined Contributions (NDCs) and outlined their plans for reducing greenhouse gas emissions. By 2030, Kazakhstan aims to reduce emissions by 15% compared to 1990, while Kyrgyzstan aims to achieve a reduction of 11.49% to 13.45%. Tajikistan's target range is a reduction of 10-20% compared to 1990 (Green Recovery and Climate Action in Central Asia, 2020).

Currently, Kazakhstan is faced with the problem of a serious deterioration of natural resources and the environment in all the most important environmental indicators. The competitiveness of "green" technologies is growing rapidly, and many alternative energy technologies soon will offer less costly ways to generate electricity compared to traditional sources.

Central Asian countries attempt for successful implementation of the green path of development, whereas the research is necessary to understand the mechanisms and factors that influence the attainment of SDGs in specific contexts (Wiesmann&Dayer, 2019). Research activities are facilitators of expansion and lead to sustainable development, while the scientific interest of Central Asia in the Green Deal related topics is indefinite. Therefore, the research aims to define the interest of researchers in the Green Deal in the context of Central Asia. Consequently, the research questions are: RQ1) How does research support the implementation of the European Green Deal and foster sustainable development? RQ2) How much attention is paid to publications on the topics attributable to the Green Deal? RQ3) What factors impact publications on the topics related to the Green Deal?

The research paper consists of 6 sections: 1) Introduction 2) Literature review: Why research in the field of Green Deal is important for Central Asian countries? 3) Methodology of conducted research 4) Conducted research and results 5) Discussions. 6) Conclusion and recommendations.

The research analysed the scientific interest in Green Deal related topics in the following countries: Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan, and Turkmenistan.

1. Literature review: Why research in the field of Green Deal is important for Central Asian countries?

Central Asian countries have been addressing energy poverty through a monopoly over their domestic energy market, but there have been no practical implementations of energy market liberalization as outlined in regulatory frameworks. Energy prices are heavily subsidized by the government, and any attempt to increase prices faces opposition. Policymakers in Central Asia consider the historical background, social policies, and potential negative impacts of energy market liberalization when forming energy policies. They are concerned about the possible increase in energy poverty, competitiveness of the economy, and potential exploitation by foreign companies with the lack of institutional control. The region's traditional isolation, state policies, and low readiness for foreign investment make it a challenging environment for foreign capital investments in energy-related projects, which are relatively small in scale. Given these considerations, the current centralized energy market structure is viewed as a suitable framework for sustainable energy transition in Central Asian countries (Radovanović, 2021).

Citizens are a critical component for all stakeholders in implementing the concepts of the green deal, particularly, the circular economy. A shift in the circular economy requires a transformation in deep ecological culture and public awareness (Elia, Gnoni & Tornese, 2017). The role of higher education is essential in realizing the Green Deal objectives. Higher education serves as a keystone in achieving the goals of the Green Deal through the implementation of competence-based study programs, which produce highly skilled specialists (Kalnbalkite, Pubule & Blumberga, 2022). According to the European Commission (2019), education policy should focus on the development of competencies to educate citizens about climate change and equip them with the necessary skills to actively participate in the transition to a more sustainable society. The Green Deal highlights the need for the greening of educational infrastructure with additional funding of €3 billion available starting in 2020 (p.19).

The Green Deal in the educational system of Central Asia has the potential to bring significant benefits to the region by promoting sustainability and combating climate change. Future generations of students will have the knowledge and skills to make informed decisions and take action to protect the environment by incorporating environmental education and sustainable practices into the curriculum. Moreover, the implementation of sustainable education courses creates job opportunities in the fields of renewable energy, energy efficiency, and sustainable construction. Additionally, the Green Deal in education can contribute to the achievement of the United Nations Sustainable Development Goals, particularly Goal 4 on quality education, goal 7 on affordable and clean energy, and Goal 13 on climate action.

Sustainability education is a crucial aspect of promoting and achieving sustainable development. The European Commission (2022) recognizes the importance of these aspects in their report, stating that "sustainability education cannot be limited to one subject only, but needs to build on an interdisciplinary approach, which runs counter to current educational structures and cultures of most national education systems... Finally, educators need specific sustainability education and training themselves, not only in terms of substance but also on teaching methods and sustainability-oriented didactics" (p. 7-8). The interdisciplinary nature of sustainability requires education systems to move beyond traditional isolated structures and adopt a holistic approach that concludes different areas and aspects of daily life. The integration of sustainability principles into education should not only cover the teaching and learning of

sustainability but also extend to the operation processes of educational institutions, such as waste management, etc.

Moreover, the effectiveness of sustainability education initiatives should be continuously evaluated to assess the impact on both individual and institutional behavior. The evaluation process improves and enhances the effectiveness of sustainability education programs. Educators, themselves, must also receive specific training and development opportunities in sustainability education, including not only knowledge on sustainability-related topics but also pedagogical approaches and teaching methods that promote sustainability-oriented education.

According to UNESCO (2019), firstly, education for sustainable development that includes green is insufficiently reflected in national policies or/and legal documents, which means a lack of vision or/and perception of it as a priority task. Secondly, educational programs in Central Asian countries are typically still focused on academic content and currently do not consider sustainable concepts and green competencies. Thirdly, teaching staff in the region face a lack of knowledge when it comes to transversal competencies and pedagogical approaches that support green courses. The trend towards rote learning continues, as faculty continue to act as information transmitters rather than intermediaries. At the same time, Central Asian countries are undergoing significant reforms at the policy and educational program levels, while these reforms do not always reach teaching staff, even though they are key participants in the implementation of these policy reforms in the classroom. Furthermore, there is a need to develop and implement faculty training programs that will allow them to effectively integrate education for sustainable development into their teaching practices. Education is important for both advancing sustainability and mitigating the economic consequences of climate change, particularly in terms of the job market and the need to adapt skills and knowledge to future work requirements (Zotti, 2022).

Bowen et al (2018) provide new insights for policymakers on green jobs and transitioning to them. Their finding reveals that green jobs vary in "greenness" (p. 264) and transitioning to indirectly green jobs is easier than directly green ones. Green jobs are categorized as Green Increased Demand, Green Enhanced Skills, and Green New and Emerging. The skill content analysis shows that Green Rival jobs have similarities to Green Increased Demand jobs. The scale and scope of job transitions in the green economy are like those in existing job transitions and smaller than those seen during the IT revolution and outsourcing, with most re-training happening on the job. The green economy has significant potential for short-term growth, subject to strategic management of job transitions (Bowen et al, 2018).

The difference in required skills between green jobs and brown jobs is minimal. Generally, the necessary skills for brown jobs are closer to those of green jobs than other types of jobs. However, some specific occupations show exceptions to this trend, such as the significance of green engineering abilities in architecture and construction, as well as the mining sphere. The impact of climate policy regulations on energy extraction jobs, like coal mining, is likely to be significant, resulting in substantial adjustment costs for workers in these sectors. Therefore, policies that aim to provide education and training for green jobs should focus on expanding specific technical programs instead of increasing post-secondary. Additionally, there is a need to prioritize targeted education and training programs that can effectively equip workers with the necessary skills for green jobs (Vona et al., 2018).

Climate policies generally have a favourable or insignificant effect on employment, but their outcomes can be unevenly distributed, leading to disadvantages for certain groups and worsening existing inequalities. The creation of low-quality jobs or weak labor market regulations can make newly created jobs less attractive and increase transition costs. The Paris

Agreement (2015) emphasizes the importance of ensuring a fair and equitable transition towards quality and decent jobs. However, delaying climate action because of fear of negative employment impacts is not recommended (Godinho, 2022)

In addition, the European Union considers Research and Innovation (R&I) as crucial for its economic growth, job creation, and social and environmental objectives. The EU R&I strategy aims to turn innovative ideas into products and services while providing investments, framework conditions, regulation, and skills (Fragkiadakis, Fragkos&Paroussos, 2020). Green innovation plays a vital role in addressing the challenges of climate change and achieving sustainable development (Noailly&Ryfisch, 2015).

2. Methodological approach

The bibliographic analysis method provides a comprehensive understanding of the current state of knowledge on the Green Deal, identifies research gaps, and guides future research. It includes a systematic literature review of existing articles, research papers, and other sources. The only reliable metrics to measure the interest of the research in Green Deal or associated topics are publications. As there is no centralized depository of publications in the local and Russian language in universities, Academies of Science and so on, we decided not to perform an analysis of the publications of uncertain value and stay only on Web of Science publications.

On 16 March 2023, a database search was conducted on the Web of Science using authors' keywords. The search terms used were ‘green transport*,’ ‘green deal,’ ‘renewable energ*,’ ‘low-carbon economy,’ ‘green logistics,’ ‘carbon neutrality,’ and "green econom*’, ‘circular econom*, ‘recycl*’, ‘green finance’, ‘low-carbon energy*’, ‘environment protection,’ ‘renewables,’ ‘climate change’, ‘renewable resources’, ‘green and sustainable finance’, ‘environmental finance’, ‘green investment’, ‘carbon emission*’, ‘sustainable agriculture’, ‘green transportation’, ‘greenhouse gas reduction’, ‘green infrastructure’, ‘clean energy*’, ‘zero waste’, ‘ecological footprint’, ‘sustainable consumption’, ‘green job’, ‘renewables’.

The publication period was restricted to the years 2018-2023. The search was further refined by limiting the results to publications originating from Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan. The bibliography was merged in Mendeley and duplicates were removed. Co-occurrence analysis of keywords and co-authorship analysis were made based on the bibliographic data analysis using VosViewer 1.6.19 software (Hernandez-Torrano, 2020).

Full counting method, the minimum number of occurrences of a keyword n=5 for the analysis of keywords and n=3 for co-authorship analysis (*Figure 1*). In addition, the analysis of publications by countries and citations by year were analyzed in the years 2018-2022.

The methodology of the research aimed at understanding the factors that influence publication activity related to the Green Deal in each of the Central Asian countries. The second step involved conducting a correlation analysis to identify the variables that have an impact on the publication activity in this specific area. The following factors were hypothesized to influence the publication activity: the number of researchers in the country, research and development (R&D) expenditure as a percentage of GDP, and the number of scientific and technical journal article publications.

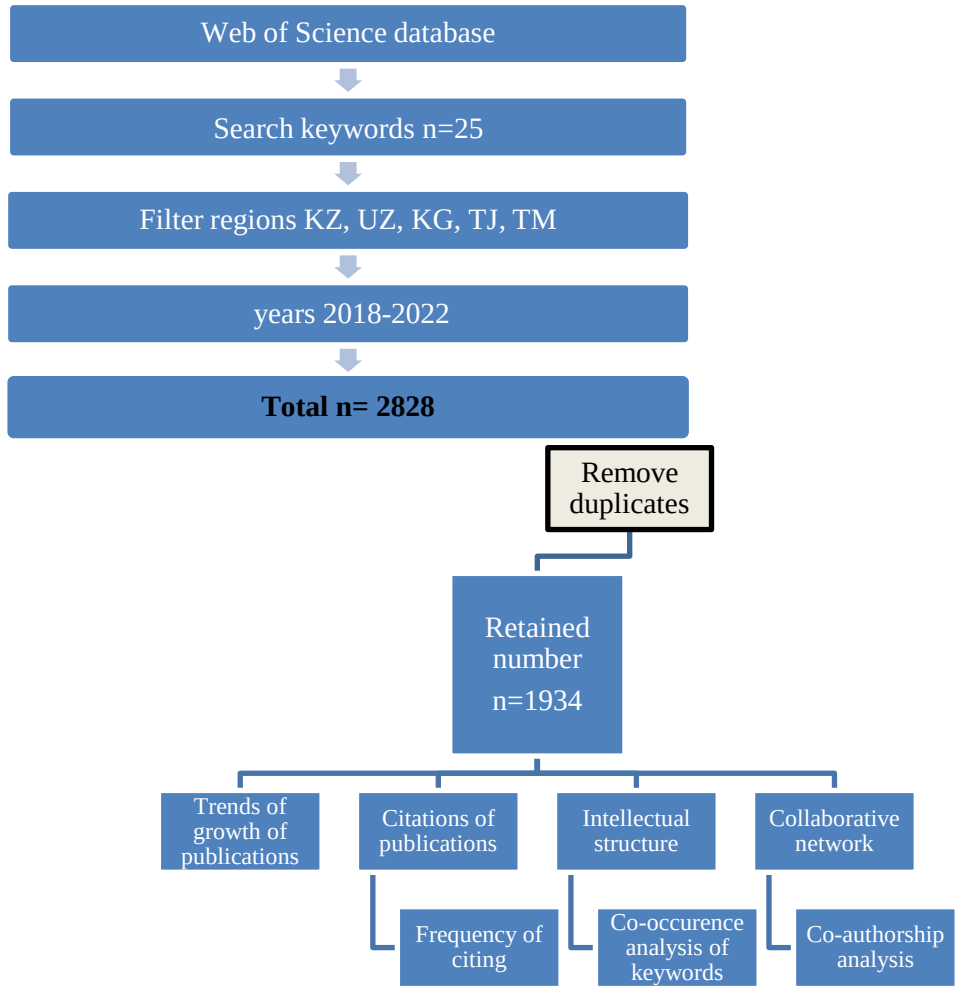

Figure 1. Framework of methodology
Source: *own compilation*

Statistical data for the analysis was obtained from the World Bank database, covering the period from 1997 to 2020. The selected timeframe aimed to capture long-term trends and potential changes over time within the chosen variables. However, data from some countries are missing.

Variables Under Consideration:

- R&D Expenditure as a Percentage of GDP reflects the investment made by each country in research and development activities that signifies the commitment to innovation and advancement within the scientific community.
- Researchers per million population serves as an indicator of the research capacity and potential for generating publications.
- General Scientific and Technical Journal Article Publications serve as a proxy for the overall scientific output of each country. Also, it indicates the level of engagement and contribution to the broader scientific community.

Correlation analysis was employed to examine the relationships between the aforementioned variables and the publication activity related to the Green Deal in each Central Asian country. Specifically, the Pearson correlation coefficient was calculated for each pair of variables to assess the strength and direction of their linear association in SPSS version 29.0.1.0.

Based on the expected impact of the variables, the following hypotheses were formulated:

(1) There is a positive correlation between R&D expenditure as a percentage of GDP and the publication activity related to the Green Deal.
(2) There is a positive correlation between the number of researchers and the publication activity related to the Green Deal.
(3) There is a positive correlation between general scientific and technical journal article publications and the publication activity related to the Green Deal.

The results of the correlation analysis provide insights into the extent and direction of the relationships between the variables. Positive correlations would indicate that higher values of one variable are associated with higher values of another, whereas negative correlations would suggest an inverse relationship. The findings contribute to a better understanding of the factors that contribute to publication activity in the context of the Green Deal within Central Asian countries.

In conclusion, the correlation analysis conducted in this research aimed to uncover the factors influencing publication activity related to the Green Deal in Central Asian countries. By examining the relationships between the number of researchers, R&D expenditure as a percentage of GDP, general scientific and technical journal article publications, and Green Deal-related publications, the study sought to provide valuable insights into the drivers of scientific output.

3. Conducting research and results

The European Union (EU) is committed to achieving climate neutrality by 2050 and acknowledges that this will require efforts across all sectors of the economy. As part of this effort, the EU plans to collaborate with international partners to enhance global environmental standards and promote sustainable practices and policies that reduce global carbon emissions. Central Asian countries are crucial partners in advancing these standards. The Green Deal is oriented towards fostering sustainability and environmental preservation objectives. This includes internalizing negative externalities, promoting energy-saving and renewable sources, discouraging anti-ecological behavior, and encouraging companies to innovate in sustainability.

To examine the research output on this topic in Central Asian countries, the study utilized the bibliographic analysis methodology proposed by Hernandez-Torrano (2020). The initial search yielded 1600 publications from Kazakhstan, 982 from Uzbekistan, 302 from Kyrgyzstan, 136 from Tajikistan, and 9 from Turkmenistan (Figure 2), with a total of 2828 articles. 894 duplicates were removed from the dataset after merging the bibliography in Mendeley to ensure data accuracy.

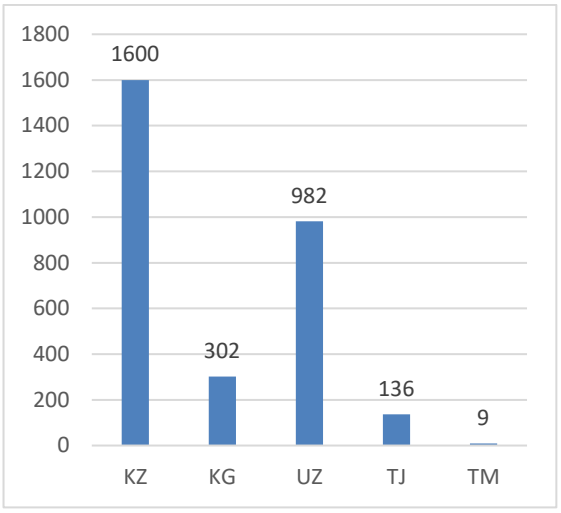

Figure 2. Number of publications in Central Asian countries in 2018-2022
Source: *own compilation*

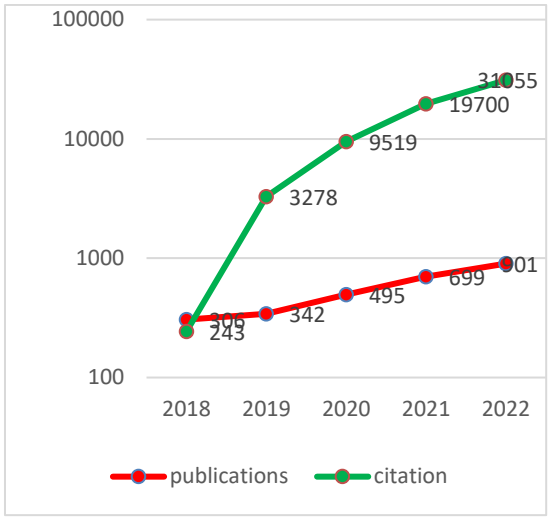

Figure 3. Number of publications by years and citations
Source: *own compilation*

The VosViewer program version 1.6.19 was utilized for graphical analysis, with co-occurrence analysis of keywords (Figure 4) and co-authorship analysis (Figure 5).

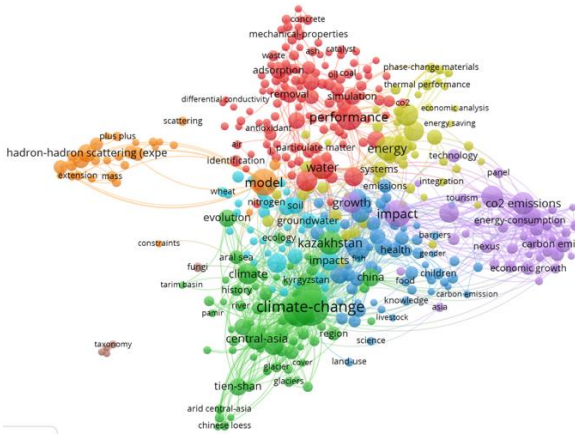

Figure 4. Co-occurrence analysis of keywords
Source: *own compilation*

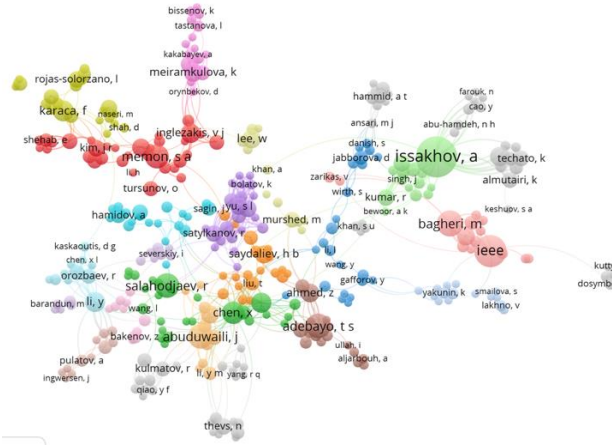

Figure 5. Co-authorship analysis
Source: *own compilation*

According to *Figure 4*, co-occurrence analysis of keywords revealed 8 clusters. They are ‘CO2 emissions and impact', 'climate change', 'energy', 'groundwater and soil', 'sustainability', 'performance', 'model', and 'taxonomy'.

(1) cluster ‘CO2 emissions and impact’ is related to research on the emission of CO2 and its impact on the environment and climate change. It includes keywords such as ‘technology’, ‘energy consumption’, ‘energy intensity’, ‘economic growth’, ‘tourism’, ‘ecological footprint’, ‘income’, and ‘financial development’.

(2) cluster 'climate change' is focused on research related to the issue of climate change, including its causes, effects, and mitigation. It includes keywords such as 'responses', 'Central Asia', 'Aral Sea', 'river basin', etc.

(3) cluster 'energy' is focused on research related to different types of energy sources, including renewable energy, fossil fuels, and nuclear power. It includes keywords such as 'optimisation', 'transition', 'wind power', and 'phase change materials.
(4) cluster 'groundwater and soil' and includes research on various ecological topics, including ecosystem dynamics, biodiversity, and conservation. It includes keywords such as 'Organic carbon', 'nitrogen'.
(5) cluster 'sustainability' is related to research on various aspects of sustainability, including health, agriculture, and policy. It includes keywords such as 'health', 'sustainable development', and 'management'.
(6) cluster ‘performance’ is related to research on the measurement and assessment of performance in various fields, including…. It includes keywords such as ‘hydrogen’, ‘carbon’, absorption., ‘nanoparticles’, and ‘degradation’.
(7) cluster 'model' includes research on various types of models used in different fields of study. It includes keywords such as 'hadron-hadron scattering', 'beyond standard model', and 'extension'.
(8) cluster ‘taxonomy’ includes research related to the classification and organization of different types of organisms. It includes keywords such as "taxonomy", "national classification", "phylogeny", ‘ascomicota’, and "fundi".

Therefore, co-occurrence analysis revealed that the Green Deal is a complex and interdisciplinary issue, that should be considered by a variety of stakeholders and researchers from different sectors. The study increased the importance of interdisciplinary collaboration.

Co-authorship analysis (*Figure 5*) identified 26 clusters, and showed patterns of collaboration among authors, based on the number of co-authored publications. The majority of authors worked together with representatives from China, Germany, the USA, England, etc. Moreover, Central Asian researchers work together in teams.

T*able 2* shows the distribution of publications on various topics in different countries, as well as the number of publications per year from 2018 to 2023. The countries included in the table are KZ (Kazakhstan), KG (Kyrgyzstan), UZ (Uzbekistan), TJ (Tajikistan), and TM (Turkmenistan).

Table 2. Distribution of publications by country and years

	distribution of publications by country						distribution of publications by years					
keywords	KZ	KG	UZ	TJ	TM	total number	2018	2019	2020	2021	2022	2023
green deal	12	4	4	1	0	19	1	2	7	4	3	2
climate change	261	88	124	55	0	495	53	72	108	119	130	13
green logistics	2	2	3	0	0	5	0	3	1	1	0	0
green econom*	79	8	39	5	1	121	15	12	22	29	39	4
renewable resources	66	9	29	10	0	106	14	7	16	25	42	2
Green and sustainable finance	16	3	13	0	0	27	3	3	3	4	12	2
Environmental finance	55	29	61	8	0	130	11	13	27	27	49	3
Green investment	12	5	14	0	0	25	3	3	3	5	9	2
Circular economy	34	2	1	0	0	37	1	2	7	8	16	3
Carbon emission*	121	6	70	2	0	191	10	17	30	48	76	10
Renewable energ*	251	22	116	3	0	373	44	41	51	104	122	11
Sustainable agriculture	127	52	97	23	3	260	30	33	59	66	65	7
Green transport*	47	12	99	2	0	152	15	7	16	39	72	3
Green job	1	2				3	1	1	1			
Carbon neutrality	3	1	7	0	1	12		0	0	3	7	2
Greenhouse gas reduction	13	1	3	1	0	18	0	2	4	5	5	2

Low-carbon econom*	16	1	3			19	1	1	3	8	5	1
Green infrastructure	12	2	138	0	0	152	22	23	18	32	55	2
Clean energ*	98	5	27	0	0	126	11	18	20	37	38	2
Zero waste	17	2	0	0	0	19	4	3	3	6	3	
Ecological footprint	6	0	13	0	0	18	1	1	1	3	11	1
Sustainable consumption	72	16	43	5	0	128	13	17	18	32	45	3
Recycl*	154	10	29	4	2	199	30	23	38	46	54	8
Environment protection	115	19	44	14	2	174	21	33	35	45	38	2
Renewables	10	1	5	3	0	19	2	5	4	3	5	0
	1600	302	982	136	9	2828	306	342	495	699	901	85

Source: *own compilation*

The highest number of publications related to these keywords have been published in Kazakhstan (1600), followed by Uzbekistan (982), Kyrgyzstan (302), and Tajikistan (136). Turkmenistan has the lowest number of publications (9). 7% of publications are made in international collaboration.

In terms of keywords, "climate change" has the highest number of publications across all countries, with a total of 495 publications, followed by "Sustainable agriculture" with 260 publications, "Recycl*" with 199 publications, and "Carbon emission*" with 191 publications.

Table 3. - Distribution of publications by citations within years 2018-2023

Keywords	citations	without self-citation	2018	2019	2020	2021	2022	2023
green deal	1762	1761	1	0	22	766	923	50
climate change	4576	4432	30	210	628	346	2600	378
green logistics	186	186		10	36	66	65	9
green econom*	3402	3391	3	7	82	1361	2016	159
renewable resources	777	759	1	18	53	142	547	101
Green and sustainable finance	620	616	0	3	55	118	379	72
Environmental finance	12624	12583	15	744	2373	4633	5674	528
Green investment	2105	2113	3	8	61	792	1175	74
Circular economy	131	124	0	0	7	23	88	19
Carbon emission*	1138	1097	5	27	77	182	1031	170
Renewable energ*	5247	5153	32	283	757	1411	3190	403
Sustainable agriculture	15600	15539	51	1311	3733	5135	6045	702
Green transport*	3272	3235	2	10	82	1421	1891	126
Green job	517	517	0	3	59	151	273	31
Carbon neutrality	92	92		0	0	1	79	16
Greenhouse gas reduction	97	97	0	2	12	33	48	2
Low-carbon econom*	209	209	0	0	3	15	160	33
Green infrastructure	1117	1049	50	188	272	371	431	38
Clean energ*	1208	1196	5	35	134	333	626	119
Zero waste	200	198	0	13	42	68	69	10
Ecological footprint	339	333	0	0	8	46	319	50
Sustainable consumption	3370	3354	21	222	644	872	1579	177
recycl*	1073	1042	11	82	183	359	450	85
environment protection	2740	2723	13	93	180	1044	1360	102
renewables	77	75	0	9	16	11	37	6
	62479	61874	243	3278	9519	19700	31055	3460

Source: *own compilation*

Table 3 shows the distribution of publications by citations within years for several keywords related to environmental and sustainability topics. The number of citations for each keyword varies greatly, with ‘Sustainable Agriculture’ having the highest number of

publications (15,600) and 'Circular Economy' having the lowest number of publications (131). For some keywords, such as 'Green Deal' and 'Green Logistics', there is a significant increase in the number of publications and citations from 2020 to 2021. There is a trend towards increased interest and research in renewable energy sources, as evidenced by the increasing number of citations for 'Renewable Energy' and Renewable Resources'. There is also growing interest in sustainable finance, as indicated by the increasing number of citations for "Green and Sustainable Finance" and "Green Investment."

High-impact publications cannot be achieved without investment in human capital and research. Innovation is a key driver of economic growth, and the Global Innovation Index (GII) in Central Asian countries is currently low relative to their level of development. However, Uzbekistan has shown a performance above expectations for its level of development. One of the most significant components of the GII is human capital and research. While data on the number of researchers in Central Asian countries is only available for Kazakhstan (629.8 per million as of 2021) and Uzbekistan (423.9 per million as of 2020), research publications serve as another indicator of research performance(WIPO, 2022).

The GII presents rankings of four Central Asian countries - Kazakhstan, Uzbekistan, Kyrgyzstan, and Tajikistan for the year 2022. The GII is a ranking of countries based on their innovation performance, and it considers six different indicators - Human capital and research, Infrastructure, Market sophistication, Business sophistication, Knowledge and technology outputs, and Creative outputs. Kazakhstan ranks the highest among the four countries in terms of GII, with a ranking of 83. Uzbekistan follows closely with a ranking of 82, while Kyrgyzstan and Tajikistan rank lower, at 94 and 104 respectively(WIPO, 2022).

In terms of the specific indicators, Kazakhstan performs the best in Human capital and research, Infrastructure, and Knowledge and technology outputs, while Uzbekistan performs the best in Market sophistication and Creative outputs. Kyrgyzstan performs relatively well in Business sophistication and Infrastructure, while Tajikistan performs relatively well in Market sophistication and Knowledge and technology outputs.

The second part of the research is dedicated to statistical analysis of factors that may impact publications regarding the Green Deal.

Kazakhstan

Statistical analysis of Kazakhstan represented by 3 variables that may impact the publication in Green Deal.

Table 4. - Descriptive Statistics - Kazakhstan

	Mean	Std. Deviation	N
Green deal articles	40.6522	62.78217	23
Research and development expenditure (% of GDP)	18.9565	4.85684	23
Researchers in R&D (per million people)	697.57	62.353	9
Scientific and technical journal articles	739.6061	814.20744	23

Source: *own compilation*

Table 4 presents the descriptive statistics for various variables in the context of Kazakhstan. There is significant variability in the number of Green Deal articles and scientific articles, as evidenced by their high standard deviations. Research and development expenditure as a percentage of GDP appears to have less variability, as indicated by its lower standard deviation. The number of observations for researchers in R&D is notably lower than for the other variables, which could impact the reliability of statistical analyses involving this variable due to the smaller sample size.

Table 5. Correlations - Kazakhstan

		Green deal articles	Research and development expenditure (% of GDP)	Researchers in R&D (per million people)	Scientific and technical journal articles
Green deal articles	Pearson Correlation	1	-.653**	-.122	.926**
	Sig. (2-tailed)		<.001	.755	<.001
	N	23	23	9	23
Research and development expenditure (% of GDP)	Pearson Correlation	-.653**	1	.549	-.728**
	Sig. (2-tailed)	<.001		.126	<.001
	N	23	23	9	23
Researchers in R&D (per million people)	Pearson Correlation	-.122	.549	1	-.301
	Sig. (2-tailed)	.755	.126		.432
	N	9	9	9	9
Scientific and technical journal articles	Pearson Correlation	.926**	-.728**	-.301	1
	Sig. (2-tailed)	<.001	<.001	.432	
	N	23	23	9	23

**. Correlation is significant at the 0.01 level (2-tailed).
Source: *own compilation*

According to Table 5, the strongest correlation (0.926) observed is between "Green Deal articles" and "Scientific and technical journal articles," which is positive and strong (0.926). This suggests that as the number of Green Deal articles increases, so does the number of scientific and technical journal articles. There is a strong negative (-0.122.) correlation between "Green Deal articles" and "Research and development expenditure (% of GDP)" (-0.653). This indicates that higher Green Deal articles are associated with lower research and development expenditure as a percentage of GDP. Similarly, a strong negative (-0.728) correlation is observed between "Research and development expenditure (% of GDP)" and "Scientific and technical journal articles"

Table 6. Regression - Kazakhstan

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Scientific and technical journal articles, Researchers in R&D (per million people), Research and development expenditure (% of GDP)[b]		. Enter

a. Dependent Variable: Green deal articles
b. All requested variables were entered.

Model Summary

					Change Statistics			
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2
1	.871[a]	.759	.615	46.11436	.759	5.258	3	5

a. Predictors: (Constant), Scientific and technical journal articles, Researchers in R&D (per million people), Research and development expenditure (% of GDP)

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	33544.217	3	11181.406	5.258	.053[b]
	Residual	10632.672	5	2126.534		
	Total	44176.889	8			

a. Dependent Variable: Green deal articles

b. Predictors: (Constant), Scientific and technical journal articles, Researchers in R&D (per million people), Research and development expenditure (% of GDP)

Source: *own compilation*

The model explains a significant portion of the variance in "Green Deal articles," as indicated by the R-squared value(Table 6). The R-squared value is 0.759, indicating that approximately 75.9% of the variance in the dependent variable ("Green Deal articles") can be explained by the independent variables in the model. The Adjusted R-squared is 0.615, which takes into account the number of predictors and adjusts the R-squared value accordingly. The standard error of the estimate is 46.11436, which provides an estimate of the variability of the dependent variable that is not explained by the model. The F-statistics significance level (0.053) suggests that the model's overall explanatory power might be marginally significant.

Uzbekistan

The statistical data for Uzbekistan is used with some missed data in 1998 and 1999 (Table 7).

Table 7. Descriptive Statistics

	Mean	Std. Deviation	N
Green Deal articles	19.2609	19.19332	23
Research and development expenditure (% of GDP)	20.14	7.150	21
Researchers in R&D (per million people)	544.81	65.650	21
Scientific and technical journal articles	412.4883	228.49737	23

Source: *own compilation*

Table 8 presents the correlation matrix, showing correlation coefficients between different variables. There is a significant negative correlation of about -0.821 between Green Deal articles and the number of researchers engaged in R&D per million people. There is a significant negative correlation of approximately -0.644 between Green Deal articles and research and development expenditure as a percentage of GDP. There is a significant positive correlation of approximately 0.778 between Green Deal articles and the number of scientific and technical journal articles.

Table 8. Correlations

		Green Deal articles	Research and development expenditure (% of GDP)	Researchers in R&D (per million people)	Scientific and technical journal articles
Green Deal articles	Pearson Correlation	1	-.644**	-.821**	.778**
	Sig. (2-tailed)		.002	<.001	<.001
	N	23	21	21	23
Research and development expenditure (% of GDP)	Pearson Correlation	-.644**	1	.845**	-.252
	Sig. (2-tailed)	.002		<.001	.270
	N	21	21	21	21
Researchers in R&D (per million people)	Pearson Correlation	-.821**	.845**	1	-.529*
	Sig. (2-tailed)	<.001	<.001		.014
	N	21	21	21	21
Scientific and technical journal articles	Pearson Correlation	.778**	-.252	-.529*	1
	Sig. (2-tailed)	<.001	.270	.014	
	N	23	21	21	23

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Source: *own compilation*

Table 9. Regression

Variables Entered/Removeda

Variables Entered	Variables Removed	Method
Scientific and technical journal articles, Research and development expenditure (% of GDP), Researchers in R&D (per million people)b	.	Enter

a. Dependent Variable: Green Deal articles
b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics			
					R Square Change	F Change	df1	df2
1	.922a	.851	.825	8.22685	.851	32.351	3	17

a. Predictors: (Constant), Scientific and technical journal articles, Research and development expenditure (% of GDP), Researchers in R&D (per million people)

ANOVAa

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6568.660	3	2189.553	32.351	<.001b
	Residual	1150.578	17	67.681		
	Total	7719.238	20			

a. Dependent Variable: Green Deal articles

b. Predictors: (Constant), Scientific and technical journal articles, Research and development expenditure (% of GDP), Researchers in R&D (per million people)

Source: *own compilation*

The R-squared value of 0.851 indicates that the model explains a significant portion of the variance in "Green Deal articles."(Table 9) The F-statistic's extremely low p-value (<0.001) suggests that the model's overall explanatory power is significant. The coefficients provide information about the relationships between the predictors and the dependent variable. The coefficients of the significant predictors suggest that an increase in scientific and technical

journal articles and a decrease in research and development expenditure and the number of researchers are associated with changes in the number of "Green Deal articles."

Kyrgyzstan

The analysis considers two factors because of the data limitation (Table 10).

Table 10. Descriptive Statistics

	Mean	Std. Deviation	N
Green deal articles	40.5217	62.86484	23
Research and development expenditure (% of GDP)	.1626	.04423	23
Scientific and technical journal articles	61.9870	46.37867	23

Source: *own compilation*

There is a strong negative correlation of approximately -0.775 between the number of Green Deal articles and research and development expenditure as a percentage of GDP(Table 11). This indicates that higher research and development expenditure is associated with fewer Green Deal articles. There is a strong positive correlation of about 0.886 between the number of Green Deal articles and the number of scientific and technical journal articles. There is a strong negative correlation of approximately -0.776 between research and development expenditure and the number of scientific and technical journal articles.

Table 11. Correlations

		Green deal articles	Research and development expenditure (% of GDP)	Scientific and technical journal articles
Green deal articles	Pearson Correlation	1	-.775**	.886**
	Sig. (2-tailed)		<.001	<.001
	N	23	23	23
Research and development expenditure (% of GDP)	Pearson Correlation	-.775**	1	-.776**
	Sig. (2-tailed)	<.001		<.001
	N	23	23	23
Scientific and technical journal articles	Pearson Correlation	.886**	-.776**	1
	Sig. (2-tailed)	<.001	<.001	
	N	23	23	23

**. Correlation is significant at the 0.01 level (2-tailed).

Source: *own compilation*

Table 12. Regression- Kyrgyz Republic

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Scientific and technical journal articles, Research and development expenditure (% of GDP)b	.	Enter

a. Dependent Variable: Green deal articles

b. All requested variables entered.

Model Summary- Kyrgyz Republic

					Change Statistics			
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2
1	.896a	.804	.784	29.21669	.804	40.927	2	20

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	69871.442	2	34935.721	40.927	<.001b
	Residual	17072.297	20	853.615		
	Total	86943.739	22			

a. Dependent Variable: Green deal articles
b. Predictors: (Constant), Scientific and technical journal articles, Research and development expenditure (% of GDP)
Source: *own compilation*

The R-squared value of 0.804 indicates that the model explains a substantial portion of the variance in "Green Deal articles" for the Kyrgyz Republic. The F-statistics extremely low p-value (<0.001) suggests that the model's overall explanatory power is statistically significant. The ANOVA results indicate that the regression model as a whole is significant in explaining the variability in the dependent variable. These results suggest that the independent variables "Scientific and technical journal articles" and "Research and development expenditure (% of GDP)" are relevant predictors for explaining the variability in the number of "Green Deal articles" in the context of the Kyrgyz Republic (Table 12).

Tajikistan

There is missed data up to 2001, therefore period from 2001-2020 is taken for correlation and regression analysis(Table 13).

Table 13. - Descriptive Statistics

	Mean	Std. Deviation	N
Green Deal articles	5.3000	7.66468	20
Research and development expenditure (% of GDP)	.0939	.01812	20
Scientific and technical journal articles	47.5365	20.86258	20

Source: *own compilation*

Table 14 presents the correlation matrix, showing the Pearson correlation coefficients between the variables "Green Deal articles," "Research and development expenditure (% of GDP)," and "Scientific and technical journal articles." Green Deal articles and Research and development expenditure (% of GDP have a positive correlation of approximately 0.126, however, this correlation is not statistically significant as the p-value is 0.597. Green Deal articles and Scientific and technical journal articles have a strong positive correlation of about 0.920. Research and development expenditure (% of GDP) and Scientific and technical journal articles have a positive correlation of approximately 0.193, but this correlation is not statistically significant as the p-value is 0.415.

Table 14. Correlations

		Green Deal articles	Research and development expenditure (% of GDP)	Scientific and technical journal articles
Green Deal articles	Pearson Correlation	1	.126	.920**
	Sig. (2-tailed)		.597	<.001
	N	20	20	20
Research and development expenditure (% of GDP)	Pearson Correlation	.126	1	.193
	Sig. (2-tailed)	.597		.415
	N	20	20	20
Scientific and technical journal articles	Pearson Correlation	.920**	.193	1
	Sig. (2-tailed)	<.001	.415	
	N	20	20	20

**. Correlation is significant at the 0.01 level (2-tailed).

Source: *own compilation*

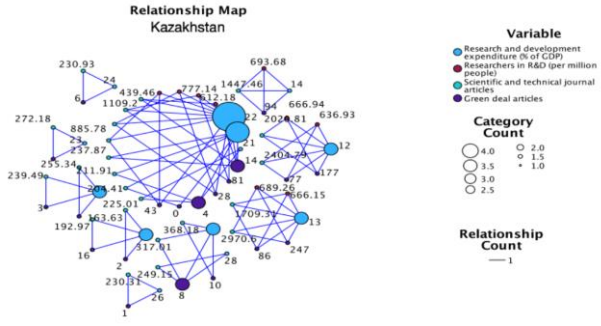

Figure 6.

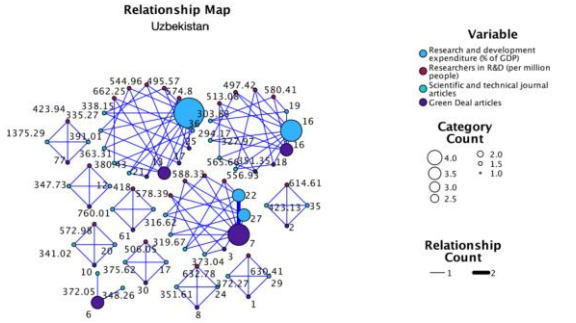

Figure 7.

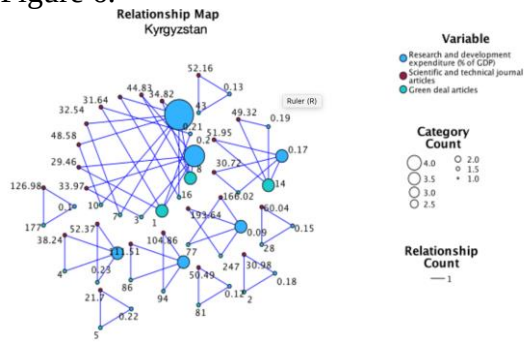

Figure 8.

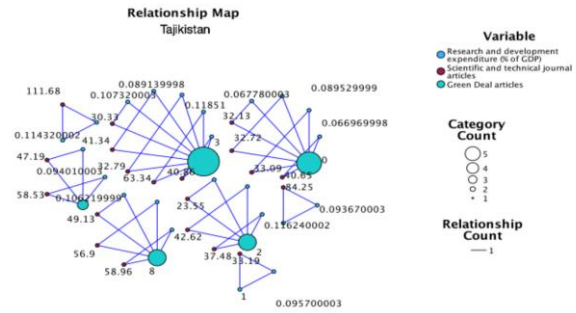

Figure 9.

Relationship maps of Central Asian countries demonstrate a strong relationship with R&D expenditure and publications in the Green Deal**.**
Source: *own compilation*

4. Discussion

In line with the objectives of the Paris Agreement on Climate Change and the European Green Deal, Universities of the EU are pursuing a strategic approach to actively contribute to the development of the circular economy, the protection of the environment, the conservation of natural resources, and the resolution of the challenges of climate change. The Green Deal is one of the most important research topics in the EU. The bibliometric analysis enabled the identification of thematic areas of international research undertaken concerning the Green Deal and compared EU and CS research directions in this area. A large part of the research directions

is similar, but it has been noticed that in the EU more attention is paid to bioeconomy development research.

Numerous nations globally are engaged in fierce competition to establish green technology as an emerging industry. Nevertheless, the development of green technology must not be solely driven by strategic objectives for industry growth, but rather by a deep commitment to the well-being of humanity and the long-term sustainability of the world ecosystem. To realize a genuinely green society, there is an urgent need for substantial investment in education and public awareness campaigns (Lee, Park& Kim, 2015). However, the implementation of the Green Deal in the education system of Central Asia faces several challenges, such as a lack of researchers and academicians specialized in sustainability, limited public awareness and engagement, and a lack of political will. Overcoming these challenges will require a comprehensive and integrated approach, involving stakeholders from government, civil society, and the private sector.

According to RQ1, the role of R&D is crucial for the European Green Deal and fostering sustainable development. Enhancing public R&D, offering subsidies to encourage private R&D, and providing subsidies to develop the necessary labor skills for the transition. Increasing low-carbon R&D both in the public and private sectors, through carbon revenue funding, results in reduced technology expenses, enhanced productivity, and GDP growth driven by innovation (Fragkiadakis, Fragkos & Paroussos, 2020).

According to RQ2, there is interest in green issues, and the number of publications is increasing. However, about 0,01% of publications belong to Central Asian researchers in comparison with the rest of the world. Central Asian researchers are working with international teams, while there is an inverse correlation between the internationalization of R&D and the advancement of environmentally friendly innovation (Zhang & Xu, 2019).

According to RQ3, R&D expenditure as a percentage of GDP has a negative correlation with Green Deal articles and doesn't imply a factor that may stimulate publication activities in Central Asian countries. Unexpectedly, the data from Kazakhstan and Kyrgyzstan demonstrates a lack of statistically significant correlation in the case of Kazakhstan and a negative correlation in the case of Kyrgyzstan. This observation also suggests that the quantity of researchers does not hold significance within the context of Central Asia. Hypothesis 3 illustrated a consistent positive correlation across all Central Asian countries. This allows us to deduce that with an escalation in the publication of scientific and technical journal articles, there is a concurrent rise in publication activity about the Green Deal.

Conclusion and recommendations

The main directions of CA research in the field of the Green Deal are Climate change, Sustainable agriculture, and recycling.

The determination of priority research directions in the field of the Green Deal provides a basis for researchers, governments, and businesses to improve development strategies and long-term courses of action.

Based on a holistic bibliographic analysis there are several recommendations to achieve carbon neutrality by 2050:

- Increase the number of researchers;
- For restricted research capacity building call from EU;
- Appeal to local governments to do specific research programs to promote Green Deal research (PCF, special grants, WB grants, specific PhD pool for Green Deal issues);
- Strengthen the role of research-industry-university;
- Promoting green behavior and skills.

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