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Research Progress of Oil Pollution on Soil Based on Bibliometric Analysis

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ABSTRACT. *Oil, one of the main energy resources of current society, has been applied in various fields, including agriculture, communications and transportation industries. However, because of the limited mining technology, corrosion and leakage of transportation pipelines, it causes harm for the environment. So it is necessary to fully and deeply understand the research progress, frontier and development trends of oil pollution on soil in the world. In this paper, we utilize bibliometric analysis to analyze oil pollution on soil and choose the core database of Web of Science to retrieve literatures from 1986 to 2018 for quantitative analysis. Besides, we also take advantage of VOSviewer to do visual analysis and obtain the Co-word network visualization map. The results suggest: (1) International research began in the early 21st century and the number of publications has grown steadily every year. (2) The highest number of published documents in the world is ENVIRONMENTAL SCIENCE AND POLLUTION RESEARCH. The average comprehensive impact factor of foreign journals is around 2.754. (3) Studies by Jacob, Daniel J are the highest number of citations internationally. (4) The proportion of basic subjects around the world is very high and the distribution of disciplines in the world is more diverse. (5) The institution with the highest number of documents in the world is CHINESE ACADEMY OF SCIENCES from China, and the highest number ofaverage citation per paper is the COUNCIL OF SCIENTIFIC INDUSTRIAL RESEARCH CSIR INDIA from India. (6) International research focuses on bioremediation technologies, including phytoremediation and microbial remediation. In short, recent and future research trends and priorities are still bioremediation technologies for oil pollution on soil. This study provides reliable reference for the government to regulate policies and further protect our environment.*

KEYWORDS: *soil; oil pollution; bibliometric; Web of science; VOSviewer*

1. Introduction

Soil is not only an important environmental basis for the survival of all kinds of organisms on the earth, but also an important place for the circulation, transformation and accumulation of substances in nature. In the past, soil pollution

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was difficult to attract people's attention because of its concealment, but at present, the indication of soil pollution is becoming more and more serious, and they are gradually becoming the focus of attention of many scholars, among which petroleum pollutants are one of the important factors leading to soil pollution [1]. At present, oil spill and soil oil pollution caused by oil exploitation have attracted more and more attention, such as the 1992 oil spill accident in Fergana Basin. Studies have shown that gas stations can also cause serious oil pollution to the surrounding soil [2].

Soil contaminated by petroleum will cause great harm to the ecological environment, meanwhile, enter the food chain to enrich, and ultimately damage human life and health [3], such as esophageal cancer [4], urethral cancer [5]; polycyclic aromatic hydrocarbons (PHAs) can also cause damage to genetic material during embryonic development and neurodevelopmental abnormalities [6]. Some studies have shown that in 2011, the concentration of oil pollution in the soil around Shengli Oilfield has reached to 2000-12000 mg/kg, and even 70000 mg/kg in some parts of Zhongyuan Oilfield [7]. Other studies have shown that Momog wetland in China has also been polluted by oil in varying degrees [8], and even the Qinghai-Tibet Plateau has been polluted by low levels of polycyclic aromatic hydrocarbons (PHAs) [9].All of these demonstrates that the current situation of soil oil pollution in China has been very serious. Due to the harm caused by soil oil pollution, many countries in the world begin to pay attention to and carry out a lot of research in order to control or improve soil oil pollution. At present, the international research on oil pollution in soil mainly focuses on bioremediation technology [10-11], in which microbial remediation technology [12] is the hotspot of remediation technology research, followed by phytoremediation technology [13]. Xu Yan's research suggests that alfalfa and ryegrass have a good effect on the remediation of oil-contaminated soil [14]. Sun Zenghui has studied the progress of the remediation of oil-contaminated soil by Nano-Photocatalyst [15], and some studies have been devoted to the detection technology of oil pollution and community structure in soil [16-17]. In order to explore the current situation, frontier trends and development trends of soil oil pollution in the world, it is essential to make quantitative statistics and analysis of the research literature related to soil oil pollution. However, at present, the number of relevant literature is too small to provide relevant researchers with the latest and relatively comprehensive reference. Therefore, this paper makes a quantitative analysis of the relevant literature in the field of soil and petroleum pollution in a timely manner, indicating the latest research trends all over the world, supplementing and summarizing the previous relevant research, in order to provide relevant researchers with timely and relatively comprehensive reference.

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2. Data sources and methodology

2.1 Data sources

The data collected in this paper is in November 3, 2018. The data are extracted from Web of Science Database Core Collection (WOS) launched by ISI. The retrieval time span is 1986-2018. In Web of science, the core database of Web of science is selected, and the KEYWORDS is “Soil oil pollution”. A total of 1542 articles are retrieved, the earliest of which was published in 1996.

2.2 Methodology

The visual analysis software used in this paper is a free bibliometric analysis software VOSviewer [19], developed by Nees Jan van Eck and Ludo Waltman of Leiden University in the Netherlands. The latest version is VOSviewer 1.6.9, and all documents are exported as data sources of VOSviewer in Web of Science. The calculation, ranking and chart making of the measurement indexes mentioned in this paper are all completed by Excel 2016. Combined with the analysis functions contained in Web of science, the field of soil oil pollution is analyzed item by item.

3. Result

3.1 Number and trend of documents

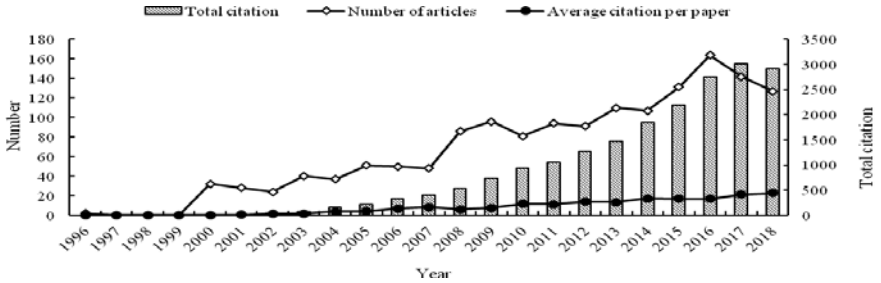

Figure. 1 Annual changes in the amount of soil oil pollution in WOS

In Figure 1, the number of English literatures has increased gradually since 2000, and the number of citations has also begun to increase steadily in the form of quadratic functions, which shows that since 2000, the field of soil and oil pollution has begun to attract world attention. At the same time, the number of citations is increasing almost in a linear way, which indicates that the research has gradually attracted the attention of many scholars around the world. It may be due to the rapid

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development of the world economy and industry, large-scale oil exploitation, and the emergence of soil oil pollution, which has caused the attention of all countries. The quality of literature from various countries and regions in Web of Science is also increasing. It is expected that the field of soil oil pollution will continue to attract worldwide attention and become a hot research area in the future.

3.2 Major country analysis

Usually, researchers hope to publish their better papers in international journals with great influence. The number of papers collected by WOS can better reflect the scientific research ability of the country or region in a certain field. Using the analysis and retrieval function of WOS, among the 1542 documents retrieved in WOS, the top ones were China (258), the United States (152), Russia (125), Nigeria (101) and India (85), which accounted for 46.76% of the total number of articles (Figure 2). Nigeria's relatively high volume of publications may be related to its being Africa's largest oil producer[19]. At the same time, among the top 20 countries, there are 8 European countries, 5 Asian countries, 4 American countries, 2 African countries and 1 Oceanian country. Developed and developing countries are equal in this field. It can be seen that this field has attracted worldwide attention, which is also related to the distribution of oil in the world[20].

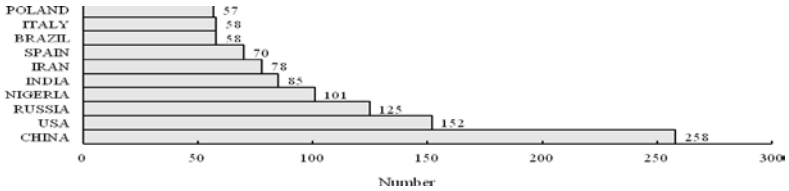

Figure. 2 Top 10 countries published in WOS

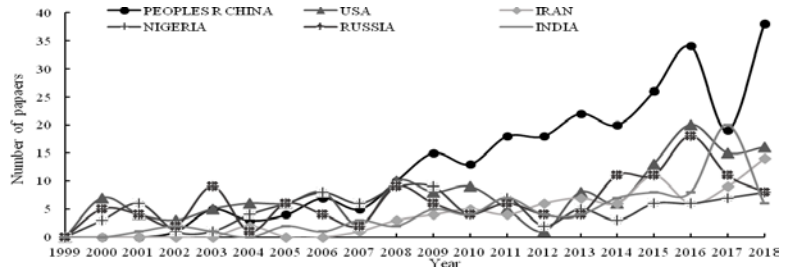

Figure.3 The top 6 national publication trends in soil oil pollution in WOS

Figure 3 is the trend of the top 6 countries in WOS. It can be seen from the figure that the United States, Russia and Nigeria have the earliest research on the field of soil oil pollution, among which the United States has a strong continuity but a large fluctuation. Other countries sometimes have intermittent situations and poor

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continuity. China started publishing articles in this field on WOS in 2002. Although it started late, the number of articles published in 2007 surpassed that of the United States. Since 2009, China has established a gap with other countries in the world. It is in a leading position in the world, far exceeding the number of articles published by other countries. In 2018, China's number of articles in this field has increased rapidly, reaching a historical peak (38 articles), which also reflects the Chinese government's concern for soil. The importance of oil pollution has gradually increased. Although other countries have a low volume of publications, they have maintained this trend of sustained growth as a whole. This is mainly due to the rapid development of heavy industry in recent years, the impact of oil on soil pollution has gradually emerged, making the world's attention to it gradually increased, and more and more countries are studying oil pollution. Countries around the world had a low ebb in 2012, but it had little impact on the future trend of publication.

3.3 Periodical analysis

Table 1 is based on the top ten journal data with analysis function in WOS. A total of 308 papers were published, accounting for 19.97% of the total number of papers. The highest number of papers was *ENVIRONMENTAL SCIENCE AND POLLUTION RESEARCH*, with 43 papers (2.79%). In Table 1, the comprehensive influencing factors of the top ten journals are counted, with an average of 2.754 (excluding *INTERNATIONAL MULTIDISCIPLINARY SCIENTIFIC GEOCONFERENCE SGEM*), which is much higher than that of Chinese journals. The most influential factor was *CHEMOSPHERE*, a Dutch journal, with a value of 4.427. Most of the top ten publications in WOS cover the fields of environment, oil pollution and water pollution.

Table 1 The top ten journals published in WOS

Journal	Number of papers	Percent	Comprehensive impact factor
ENVIRONMENTAL SCIENCE AND POLLUTION RESEARCH	43	2.79%	2.800
ENVIRONMENTAL MONITORING AND ASSESSMENT	41	2.66%	1.804
SCIENCE OF THE TOTAL ENVIRONMENT	40	2.59%	4.610
EURASIAN SOIL SCIENCE	32	2.08%	0.667
WATER AIR AND SOIL POLLUTION	31	2.01%	1.769
CHEMOSPHERE	30	1.95%	4.427
INTERNATIONAL BIODETERIORATION & BIODEGRADATION	25	1.62%	3.562
INTERNATIONAL MULTIDISCIPLINARY SCIENTIFIC GEOCONFERENCE SGEM	23	1.49%	--
ATMOSPHERIC ENVIRONMENT	22	1.43%	3.708
ENVIRONMENTAL EARTH SCIENCES	21	1.36%	1.435

“--”represents data missing

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2.4 Citation Analysis

Table 2 The top ten literatures of soil oil pollution in WOS

Title	Journal	Total citation
Effect of climate change on air quality	ATMOSPHERIC ENVIRONMENT	606
Polycyclic aromatic hydrocarbons: environmental pollution and bioremediation	TRENDS IN BIOTECHNOLOGY	521
The green, blue and grey water footprint of crops and derived crop products	HYDROLOGY AND EARTH SYSTEM SCIENCES	416
Monitoring of environmental exposure to polycyclic aromatic hydrocarbons: a review	ENVIRONMENTAL CHEMISTRY LETTERS	337
Environmental Applications of Biosurfactants: Recent Advances	INTERNATIONAL JOURNAL OF MOLECULAR SCIENCES	256
Degradation of alkanes by bacteria	ENVIRONMENTAL MICROBIOLOGY	229
A review of earthworm impact on soil function and ecosystem services	EUROPEAN JOURNAL OF SOIL SCIENCE	208
Integrated nitrogen management strategies to improve seed yield, oil content and nitrogen efficiency of winter oilseed rape (Brassica napus L.): A review	AGRICULTURE ECOSYSTEMS & ENVIRONMENT	185
Distribution and origins of polycyclic aromatic hydrocarbons (PAHs) in riverine, estuarine, and marine sediments in Thailand	MARINE POLLUTION BULLETIN	168
Characteristics of lead isotope ratios and elemental concentrations in PM10 fraction of airborne particulate matter in Shanghai after the phase-out of leaded gasoline	ATMOSPHERIC ENVIRONMENT	153

Table 2 is the first ten cited documents in WOS. Jacob and Daniel J are the most cited ones. The effect of climate change on air quality[21] published by *ATMOSPHERIC ENVIRONMENT* in 2009 has reached 606 cited times. From table 1, we can see that the impact factor of *ATMOSPHERIC ENVIRONMENT* is 3.708. Secondly, Samanta, SK and others published *Polycyclic aromatic hydrocarbons: environmental pollution and bioremediation*[22] on *TRENDS IN BIOTECHNOLOGY* in 2002. The number of citations reached 521, and the impact factor of *TRENDS IN BIOTECHNOLOGY* was 13.578. It can be seen that *TRENDS IN BIOTECHNOLOGY* has a greater impact on the international community, and the quality of texts is relatively high.

3.5 Discipline analysis

Fig. 4 is the top ten disciplines in WOS, among which ENVIRONMENTAL SCIENCES ECOLOGY ranks first, with 803 papers published, followed by ENGINEERING, 276 papers published, and there is a small gap in the number of

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other disciplines. Soil oil pollution is regarded as an environmental science and engineering problem in the world, and is also involved in chemical and geographic disciplines. However, soil oil pollution is more likely to affect crop cultivation and water resources utilization. Generally speaking, basic disciplines still account for a large proportion.

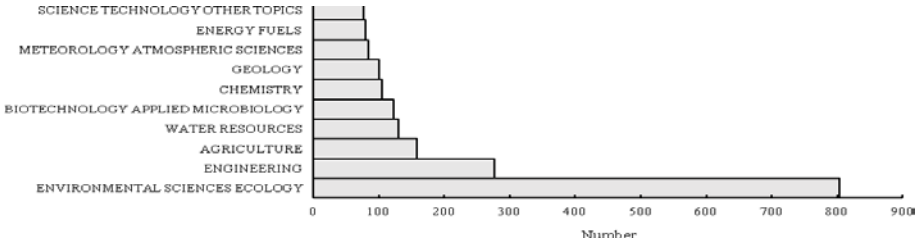

Figure. 4 The top ten disciplinary distributions published in WOS

3.6 Institutional Analysis

Table 3 shows that the top 12 research institutions in WOS have published 307 papers, accounting for 19.91% of the total. The highest number of papers is CHINESE ACADEMY OF SCIENCES, which reaches 67 papers (4.35%), far more than other research institutions. This shows that China attaches great importance to the field of soil oil pollution. As it can be seen from Figure 2, the highest number of papers is CHINESE ACADEMY OF SCIENCES. The total number of citations was 1521, and the average number of citations was 22.7. The second was RUSSIAN ACADEMY OF SCIENCES from Russia, with 44 (2.85%) articles, 254 citations and 5.77 citations. Meanwhile, the top three cited institutions are COUNCIL OF SCIENTIFIC INDUSTRIAL RESEARCH CSIR INDIA (64.6), CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS CSIC (39.83) from Spain and CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS (30.13). The total number of articles published in the remaining journals is not much different, but the number of citations per article and the total number of citations are uneven. Some organizations should also strengthen the quality of the articles.

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Table 3 The top 15 research institutions in WOS

Research institute	Number	Average citation per paper	Total citation
CHINESE ACADEMY OF SCIENCES	67	22.7	1521
RUSSIAN ACADEMY OF SCIENCES	44	5.77	254
LOMONOSOV MOSCOW STATE UNIVERSITY	28	4.71	132
KUWAIT UNIVERSITY	27	15	405
ISLAMIC AZAD UNIVERSITY	24	3.67	88
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS CSIC	23	39.83	916
UNIVERSITY OF TEHRAN	17	3.65	62
UNIVERSITY OF CHINESE ACADEMY OF SCIENCES CAS	17	14.59	248
UNIVERSITY OF PORT HARCOURT	15	8.4	126
CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	15	30.13	452
COUNCIL OF SCIENTIFIC INDUSTRIAL RESEARCH CSIR INDIA	15	64.6	969
UNIVERSITY OF CALIFORNIA SYSTEM	15	22.8	342

3.7 Keyword analysis

Table 4 Word frequency ranked in the top 36 keywords in WOS

Keyword	Frequency	Keyword	Frequency	Keyword	Frequency
environmental sciences & ecology	714	soils	117	meteorology & atmospheric sciences	72
pollution	285	water resources	112	remediation	72
soil	279	biotechnology & applied microbiology	111	china	71
bioremediation	259	chemistry	106	geology	70
biodegradation	209	contamination	103	pahs	69
engineering	196	water	90	microorganisms	68
polycyclic aromatic-hydrocarbons	171	heavy-metals	89	soil pollution	67
degradation	159	heavy metals	88	science & technology - other topics	67
oil	153	phytoremediation	81	microbiology	65
agriculture	138	contaminated soil	79	bacteria	64
hydrocarbons	130	oil pollution	78	air-pollution	63
crude-oil	129	sediments	76	energy & fuels	60

Table 4 is the top 36 words in WOS. The top three words are Environmental Sciences & ecology, pollution and soil, followed by bioremediation, biodegradation,

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engineering and polycyclic aromatic-s. Hydrocarbon at all. Through the analysis of Table 4, it can be witnessed that in the field of soil oil pollution, international research mainly focuses on biodegradation of hydrocarbons, phytoremediation and chemical remediation. Because of the advantages of high efficiency, no secondary pollution, low cost and so on, these remediation methods have become the research hotspot of the vast number of researchers [23]-[24]. At the same time, it is consistent with Li Zhilin's research in June 2018[25]. Among the top 36 high frequency sub-keywords, the frequency of China is 71, which also shows that there are relatively more studies in the field of soil oil pollution in China, which is consistent with the previous conclusions.

3.8 Keyword co-occurrence analysis

Co-occurrence analysis of keywords is a bibliometric method, which can be used to judge the direction of research in a field or the relationship between topics. It is one of the most popular bibliometric methods [26]-[27]. Figure 5 is a map of scientific knowledge drawn by selecting the first 351 keywords in WOS. In Figure 5, Environmental Sciences & Ecology (environmental science and technology) occupies the core position, indicating that the literature category analyzed belongs to environmental science and technology, which is also consistent with the analysis results in Figure 4. Bioremediation (biodegradation) is also a hot topic in international research, including phytoremediation, microbial remediation and plant-microbial remediation. Bioremediation methods, such as bioremediation, biological stimulation and bio-enhancement, are almost the same as domestic research hotspots. Polycyclic aromatic-hydrocarbons (PAHs), hydrocarbons , air-pollution, heave-metals, toxicology and water resources are associated with pollution in Figure 5, which indicates that the pollutants studied are mainly polycyclic aromatic hydrocarbons. At the same time, soil oil pollution is related to many disciplines, including air pollution and water pollution. Toxicology is also involved. This shows that some international studies have already involved the toxicological effects of soil oil pollution. At the same time, some scholars have also studied the growth status of plants in oil-polluted soil[28]. It can also be seen from the figure that the related research on soil oil pollution is mainly concentrated in China, and slightly involved in Hong Kong, China, as well as other countries such as Niger, which indicates that soil oil pollution has attracted much attention and research in China.

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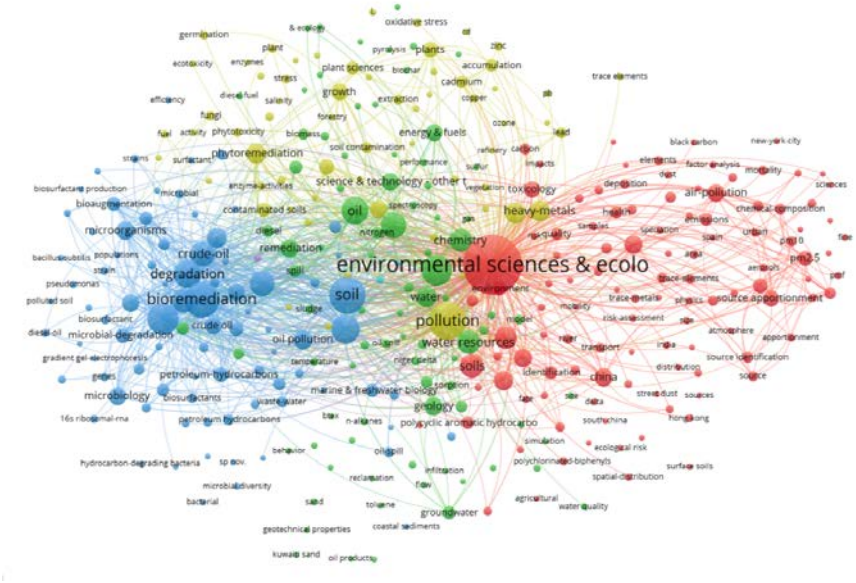

Figure. 5 Network visual map of high frequency KEYWORDS in WOS

4. Conclusion

Through the analysis of the above seven aspects, this paper draws the following conclusions:

(1) Environment, environmental engineering and other basic disciplines account for a large proportion of the disciplines of soil petroleum pollution research internationally. At the same time, soil petroleum pollution has gradually endangered the development of crop cultivation and forestry. The field of soil petroleum pollution has attracted the attention of other disciplines. The distribution of disciplines is diversified. It is expected that more documents will be published in other disciplines in the future, and other disciplines will join in. For example, water resources and so on, show diversified development in general.

(2)From the international point of view, in 2000, soil oil pollution began to attract the attention of researchers all over the world, and the number of research began to increase year by year, which is related to the rapid development of world economy, heavy industry and the serious soil oil pollution caused by large-scale oil exploitation all the year round. However, since 2017, the number of documents and the total number of citations in the world have been increased. It could be witnessed that foreign researchers are more focused on the quality of the articles.

(3) It can also be seen from the co-occurrence network visualization that the research on bioremediation technology of oil contaminated soil is a hotspot and

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focus for scholars. It is expected that these remediation technologies will continue to be concerned by all countries in the world in the future. Microbial remediation technology and bio-enzymes degradation of oil contaminated soil will become an important breakthrough. In the future research, we could focus on high efficiency and convenience as far as possible, and study the treatment methods of degrading petroleum pollution, so as to achieve the effect of rapid remediation of important soil resources such as farmland and woodland. At the same time, there are few studies on the prevention and control of soil oil pollution internationally. If we can improve the prevention and control measures of soil oil pollution, it will undoubtedly be of great help to reduce the harm of soil oil pollution, and we can pay more attention to this aspect.

At present, the global oil development is in a rapid development stage. Soil oil pollution will continue to be the focus of world scholars, which also reflects that its remediation technology is still and will continue to become a research hotspot of world researchers.

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References

[1] LI Jia, CAO Xing-tao, SUI Hong, et al (2017). Overview of Remediation Technologies for Petroleum-Contaminated Soils. Acta Petrolei Sinica (Petroleum Processing Section), vol.33,no.5, pp.811-833.

[2] ZHANG Hong-kai, ZUO Rui, WANG Jin-sheng, et al (2018). The underground migration and distribution of petroleum contamination at a gas station. China Environmental Science, vol.38, no.4, pp.1532-1539.

[3] ZHENG Xue-cheng, LIN Xiao-sha, NIE Xin-tong, et al (2018). Study on Effect of Electric Field-Surfactant on Degradation and Transfer of Petroleum Hydrocarbon in Drillings. Contemporary Chemical Industry, no.11, pp. 2252-2254.

[4] KAMANGAR F, STRICKLAND PT, POURSHAMS A, et al (2005). High exposure to polycyclic aromatic hydrocarbons may contribute to high risk of esophageal cancer in northeastern Iran.Anticancer Res, vol.25, no.1B, pp. 425-428.

[5] BOSETTI C, BOFFETTA P, LA Vecchia C (2007). Occupational exposures to polycyclic aromatic hydrocarbons, and respiratory and urinary tract cancers:aquantitative review to 2005. Ann Oncol, vol.18, no.3, pp.431-446.

[6] LIANG Yi-qun, ZHANG Feng-hua (2016). Analysis of neurotoxic effects of polycyclic aromatic hydrocarbons on early childhood development. Maternal and Child Health Care of China, vol.31, no.23, pp.5217-5219.

ISSN 2616-7433 Vol. 1, Issue 8: 1-13, DOI: 10.25236/FSST.2019.010801

[7] DU Wei-dong, WAN Yun-yang, ZHONG Nin-ging, et al (2011). Current Status of Petroleum-Contaminated Soils and Sediments. Journal of Wuhan University: Natural Science Edition, vol.57, no.4, pp.311-322.
[8] XU Jian-ling, WANG Han-xi, SHENG Lian-xi, et al (2017). Distribution Characteristics and Risk Assessment of Polycyclic Aromatic Hydrocarbons in the Momoge Wetland, China. International Journal of Environmental Research and Public Health, vol.14, no.1, pp.85-86.
[9] ZHOU Wen-wen (2018). Distribution Characteristics, Sources and Risk Assessment of Polycyclic Aromatic Hydrocarbons in Surface Soils in the Central and Eastern Qinghai-Tibet Plateau. Tianjin Normal University.
[10] YU Yi-lei, MA Mu-yuan, XU Wei-gang, et al (2018). Study on the Remediation of Soil Contaminated by Crude Oil Using Suaeda salsa in Yellow River Delta. Ecology and Environmental Sciences, vol.27, no.10, pp.1958-1965.
[11] ZARGAR M, SARRAFZADEH MH, TAHERI B, et al (2013). The Surveying of Soil and Groundwater Pollution in a Petroleum Refinery and the Potential of Bioremediation for Oil Decontamination. Petroleum Science And Technology, vol.13, no.24, pp.2585-2595.
[12] LIU Xian-bin, REN Li-jun, TIAN Sheng-yan, et al (2014). Screening and identification of thick oil degrading microorganism and its degradation characteristics. Chinese Journal of Environmental Engineering, vol.8, no.7, pp.3069-3074.
[13] LIAO Chang-jun (2015). Remediation of Crude Oil Contaminated Soil by Maize CT 38. South China University of Technology.
[14] XU Yan, WANG Shu-guang, DENG Fu-ling (2018). Remediation effect of alfafa and ryegrass on oil-contaminated soil. Land Development and Engineering Research, vol.3, no.11, pp.29-34.
[15] SUN Zeng-hui (2018). Study on Nano Photocatalyst in the Remediation of Petroleum Contaminated Soil. Resources Economization & Environmental Protection, no.10, pp.81-82.
[16] QI Yan-yun, WU Man-li, ZHU Chang-cheng, et al (2019). Microbial Community Structure Shift During Bioremediation of Petroleum Contaminated Soil Using High Throughput Sequencing. Environmental Science,no.2, pp.1-10.
[17] ALI Khumaeni, WAHYU Setia BUDI, ASEP Yoyo Wardaya, et al (2016). Rapid Detection of Oil Pollution in Soil by Using Laser-Induced Breakdown Spectroscopy. Plasma Science and Technology, vol.18, no.12, pp.1186-1191.
[18] NEES Jan Eck, LUDO Waltman (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. Scientometrics, vol. 84, no.2, pp.523-538.
[19] Nigeria Country Profile, People's Republic of China Ministry of Foreign Affairs, [EB/OL]. [2018-12-3] https://www.fmprc.gov.cn/web/gjhdq_676201/gj_676203/fz_677316/1206_678356/1206x0_678358/
[20] HAO Li-sha, ZHAO Yuan (2010). Spatial Distribution Pattern of Global Oil Resources and Its Evolution . Journal of Natural Resources, vol. 25, no. 11, pp.1897-1906.
[21] DANIEL J. Jacob, Darrell A. Winner (2009). Effect of climate change on air quality. Atmospheric Environment, vol.43, no.1 pp.51-63.

ISSN 2616-7433 Vol. 1, Issue 8: 1-13, DOI: 10.25236/FSST.2019.010801

[22] SUDIP K Samanta, Om V Singh, Rakesh K Jain (2010). Polycyclic aromatic hydrocarbons: environmental pollution and bioremediation. Trends in Biotechnology Winner, vol.20, no.6, pp.243-248.
[23] HUI Yun-fang, WANG Hong-fei (2018). Rogress On Bioremediation In Oil-Contaminated Soi. Acta Agriculturae Boreali-occidentalis Sinica, vol.27, no.4, pp.451-458.
[24] ZHANG Lei, Zhao Qi, Wu Wei-nan, et al (2018). Status and prospects on bioremediation technologies for petroleum contaminated soil. Modern Chemical Industry, vol.38, no.1, pp.18-22.
[25] LI Zhi-lin, XIE Yu-feng, JIANG Jing-yan, et al (2018). Bibliometric Analysis of Soil Oil Pollution Research Based on Web of Science Database in Past 30 Years . Chinese Journal of Soil Science, vol.49, no.4,pp.1001-1008.
[26] A. Cambrosio, C. Limoges, J. P. Courtial, F. Laville (1993). Historical scientometrics? Mapping over 70 years of biological safety research with coword analysis. Scientometrics, vol. 27, no.2, pp.119-143.
[27] XIE Cai-xia, LIANG Li-ming, WANG Wen-hui (2005). KEYWORDS co-occurrence analysis of nanotechnology papers in China. Journal of Intelligence, no.3, pp.69-73.
[28] Bamidele J F, Agbogidi O M (2006). The effect of soil pollution by crude oil on seedling growth of machaerium lunatus (L) G. F. W. meg. Discovery & Innovation, vol.18, no.2 pp.104-108.