

EMERGENCY RISK ASSESSMENT AND RESCUE OF GROUNDWATER POLLUTION CAUSED BY MINING BASED ON 5G NETWORK

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Highlights:

- the rapid development of China's economic construction has a strong demand for mineral resources;
- a novel emergency risk assessment and rescue of groundwater pollution based on 5G technology;
- groundwater pollution caused by mining.

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Abstract. Recently, heavy metal pollution of soil, land degradation and groundwater pollution generated due to the lack of supporting environmental protection measure, which not only endanger human health, but also affect the sustainable development of mining industry. In order to avoid groundwater pollution, and improve risk assessment and rescue levels of underground water pollution, and a wireless remote emergency risk assessment and rescue system based on 5G core network is constructed, and emergency risk assessment model of groundwater pollution caused by mining is designed. The types of ground water pollution are analyzed. The emergency risk assessment of groundwater pollution is carried out, and the evaluation method of groundwater pollution is designed. A data mining algorithm is designed for optimizing 5G communication network. Taking groundwater in a mining area as the research object, 15 heavy metal indexes of 12 monitoring wells in the mining area were monitored and analyzed. The results show that proposed emergency risk evaluation and rescue of groundwater pollution caused by mining based on 5G network has better communication performance, indexes of as, Sb, Co, Fe and Mn in underground water exceed the standard. And then 5G core network construction of groundwater pollution emergency risk assessment and rescue concludes user plane function/mobile edge computing (UPF/MEC) sink and independent private network is achieved. A case study is carried out using a coal mine as researching object, results showed that proposed remote emergency risk assessment and rescue of groundwater pollution has less time delay and packet loss rate, therefore proposed emergency risk assessment and rescue of groundwater pollution has better communication performance. Finally, the emergency rescue countermeasures of groundwater pollution are taken according to evaluation results.

Keywords: groundwater pollution, mining, emergency risk assessment.

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1. Introduction

The rapid development of China's economic construction has a strong demand for mineral resources, which makes the mining industry develop too fast and extensive for a long time in the past. Due to the lack of supporting environmental protection measures, a large number of heavy metal elements are released into the environment by the waste residue, waste water and waste gas generated in the smelting process of the mine result in heavy metal pollution of soil, land degradation and groundwater pollution, which not only endanger human health, but also affect the sustainable development of mining industry.

The rapid expansion of mine production scale has brought serious environmental problems. The soil,

groundwater and surface water in the mining area are seriously polluted by heavy metals, especially the groundwater pollution caused by smelting waste residue and tailing. Heavy metal ions in tailing infiltrate into the soil under the action of rainwater leaching, and then migrate along the direction of groundwater movement through complex chemical processes, thus causing serious pollution to groundwater in the mining area and downstream, further aggravating the water resource crisis in China heavy metal pollution has become a prominent environmental problem in China for a long time (Zeng et al., 2018).

Groundwater resources account for 30% of the total water resources reserves. More than 70% of the global population's drinking water belongs to groundwater resources. In a broad sense, groundwater includes all the

water bodies existing in the ground or in the state of movement, but generally, groundwater refers to the water resources in the first aquiclude (Sahoo & Khaoash, 2020). Groundwater can be subdivided into deep groundwater and shallow groundwater. Among them, the renewal rate of shallow groundwater is relatively large, which can directly participate in the circulation of water body; while the renewal ability of deep groundwater is weak, so it can not participate in the water circulation movement in nature at the normal speed. In coastal areas, seawater intrusion and recharge, industrial waste discharge, agricultural pollution, urban life pollution and other factors will lead to serious groundwater pollution problems.

In order to speed up the pace of industrialization, the frequent construction of large-scale mining projects leads to serious subsidence of geological ground in the mining area. A part of the surface soil layer collapses seriously, and a large number of dust particles, sand and gravel soil blocks enter the shallow groundwater, and with the natural water circulation, it causes serious harm to human health (Zhao et al., 2019a).

With application of 5G technology, 5G will be highly introduced into industry field. In order to effectively assess risk of groundwater pollution caused by mining, it is necessary to construct emergency risk assessment and rescue system of underwater pollution caused by mining based on 5G technology. 5G communication technology provide technical support for smart emergency risk assessment and rescue platform. This research constructs 5G communication system for emergency risk assessment and rescue of groundwater pollution caused by mining, which has significant theoretical significance and practical value.

5G technology has characteristics of super large bandwidth, super high reliability and super low latency, which can integrate intelligence and big data technologies, which can assist in high quality and diversified risk assessment and rescue of groundwater pollution by mining. Risk assessment and rescue scheduling platform of groundwater pollution by mining can be constructed based on 5G technology, which can achieve effect resource management and optimal emergency measures. In recent years, 5G technology has been successfully applied in many fields, Vargas and Tien (2023) applied 5G technology in risk assessment of critical infrastructure system with good effect. Klimczak-Bitner et al. (2021) used 5G management platform as a prognostic biomarker for esophageal cancer. Lu et al. (2023) designed a three dimensional rescue system based on 5G technology, which could be effectively applied in public emergencies. Batistatos et al. (2023) proposed a communication platform based on 5G technology with good performance. Liu et al. (2023) proposed as versatile link level simulator towards 5G new radio sidelink communications, and tested performance of this system. As seen from existing achievements, 5G technology can be effectively applied in risk assessment and rescue of complex system, therefore it is feasible to apply 5G technology to risk assessment and rescue of underground water pollution caused by mining.

Research on mining based on 5G Network has also concerned by some scientists, Sun (2021) studied the characteristics and scope of application of mining 5G technology in the intelligentization of coal mines, clarified the research and development direction and principles of mining 5G systems, and pointed out that the research and development of mining 5G is not only about explosion-proof transformation of existing ground 5G products. At the same time, Sun (2020) also studied the intelligentization of coal mines and mining 5G and network hard slicing technology, pointing out that the comprehensive carrier network and network hard slicing technology are key technical equipment supporting the mining 5G carrier network. Meng (2020) studied the application architecture of 5G technology in coal mines and proposed a deployment plan for 5G systems in coal mines. Li Chenxin studied the evolution technology of 5G communication in mining and pointed out that the Redcap lightweight module and integrated communication positioning are suitable for the 5G field in coal mines. Chang et al. (2021) conducted security research on the 5G communication system in coal mines, proposing specific calculation and testing methods for transmission threshold power parameters, electromagnetic compatibility, system networking, and other aspects. Zhang (2021) studied the security application technology of 5G communication system in coal mines and proposed the key design of intrinsic safety of antenna isolation circuit output signal. Huo (2022) studied the current situation and development trend of wireless communication systems in mines, and pointed out that explosion-proof and intrinsically safe 5G base station equipment for coal mines is inconvenient to use and has limited usage scenarios. Therefore, research and development of intrinsically safe 5G base station equipment for coal mines should be carried out.

This research put forward a novel emergency risk assessment and rescue of groundwater pollution based on 5G technology. The organization of this research is listed as follows: the main groundwater pollutions caused by mining are analyzed. And then application of 5G technology on mining engineering is discussed. And then remote emergency risk assessment and rescue system of groundwater pollution is designed by using 5G communication technology. Finally, the performance of proposed remote emergency risk assessment and rescue system is verified through simulation analysis.

2. Groundwater pollution caused by mining

(1) Direct pollution

The pollution of waste rock, tailing and sewage discharged in the process of mineral processing on water environment. A large number of waste rocks will be produced in the process of mining. For most mining enterprises, the way they treat the waste rocks is just to stack them on the surface at will. With the erosion of rainwater and the role of microorganisms, the leach-ate produced by these waste

rocks will cause serious harm to the underground water system of the mining area. The trace elements contained in the waste rock are oxidized and decomposed, and microorganisms decomposition and other processes form a large number of metal ions in acidic waste-water, when these waste-water permeate into the groundwater system, it will cause groundwater pollution. In the process of mineral processing, ore will also produce a large amount of waste-water after various procedures. At present, for most mining enterprises, this part of waste-water is often directly discharged into the external environment without treatment. Because the waste-water contains a large number of trace elements, it will enter the groundwater system after infiltration, causing groundwater pollution (Augustsson et al., 2020). A new type of similar material suitable for coal mine in exposed karst areas was developed, which could more truly reflect the dynamic formation process of mine water inflow (Li et al., 2024).

At present, China's coal reserves exceed 3 billion tons, covering an area of more than 12000 hectares, and is still growing at the rate of 130 million tons per year (Li Kexin, 2023). In coal mining cities, coal mines are all over the country, and fly ash is discharged and accumulated in the ash yard. Toxic and harmful elements (copper, lead, zinc, etc.) in coal mines and fly ash can leach into the soil, and migrate to the shallow groundwater with rainwater and pollute the shallow groundwater resources.

Generally speaking, the mine water is weakly alkaline with pH value between 7–8. However, sulfur-containing mine water contains more SO_4^{2-} ions, showing weak acidity. In sulfur bearing mine, groundwater permeability is high, ventilation conditions are good in roadway, sulfide in ore and sulfur-containing coal in mine water form acid water under the oxidation and decomposition of microorganisms. With the surface water seeping into the phreatic layer, groundwater pollution is eventually caused. According to statistics, if the use of backwater is not considered, the waste water discharge per ton of ore is about 1 cubic meter; the waste water discharge of 1 ton of raw coal is about 0.5–10 cubic meters, up to 60 cubic meters. Moreover, after many old mines stop production, the residual ore in the roadway will continue to produce mineral waste-water, resulting in the continuous deterioration of the mining environment, and its impact will far exceed the mining area itself (Zhu et al., 2020).

(2) Indirect pollution

The indirect pollution of underground water system caused by mining is mainly manifested in the surface subsidence and groundwater level drop. The sewage produced in the mining process directly permeates into the groundwater through the underground river channel and collapse tunnel, resulting in groundwater pollution, which brings unimaginable consequences (Zhao et al., 2019b). For example, the indirect pollution of karst water around many mines nowadays is mainly due to the opening of the channel between the Quaternary aquifer and the karst

aquifer due to the ground subsidence during the mining process, which causes the polluted water from mining to infiltrate into the groundwater system. As the Quaternary aquifer is mainly composed of sand and gravel, the polluted water enters the karst aquifer through the gravel layer. The karst water is polluted. In addition, due to the decline of groundwater level, people are forced to abandon the shallow mining depth. However, in the process of mining karst water, the pollutants in the upper water layer enter into the karst aquifer through the outer wall of the well pipe due to the need to pass through the upper layer of the poor water quality during the mining of karst water (Aithani et al., 2020).

3. Application status of 5G technology on mining

Quick development of science and technology promotes advancement of 5G communication technology, 5G technology is upgrade of 4G technology, 5G is further extension of technical content of 4G. 5G communication technology has been applied in uplink and downlink decoupling, dense network, multiple input and multiple output, and beam forming technology, the running speed and capacity of network are improved greatly, therefore 5G communication technology has super high speed and broadband, and low running speed and capacity. 5G communication technology has been successfully applied in many fields. Application of 5G communication technology on mining industry is in stage of experience accumulation period. Related experts carry out pre judgment for application of 5G communication technology on mining industry, and analyze necessity and feasibility of 5G communication technology on mining industry. 5G wireless communication technology can be used to construct wireless communication network, real application scene of 5G technology on mining has been described. In recent years, 5G communication technology can be applied in many aspects of mining, such as vehicle driverless of down hole operation, robot operation, data information transmission of Internet of Things, underground environment motoring and security, mining intelligent working plane, and so on. Currently 5G communication technology has not applied in emergency risk evaluation and rescue of groundwater pollution. To effectively evaluate risk and rescue of groundwater pollution, down hole needs stable transmission signal of system, currently mining data transmission mainly uses power cable carrier and optical fiber technology, discount rate of used cable is very high, therefore data transmission interruption events occur frequently. Current data transmission means needs excessive video signal cable and sensors, working load of normal maintenance. In addition, down hole operation is very complex, therefore signal is unstable, and remote stable emergency risk evaluation and rescue of groundwater pollution caused by mining can not be ensured. Wired transmission of data needs a lot of related devices erected, therefore maintenance working

amount is very heavy, and mining always fixes most sensors on critical devices, in order to avoid these problems, 5G communication device can be used to achieve wireless transmission of data, therefore wireless emergency risk evaluation and rescue of groundwater pollution based on 5G can reach simple structure and less maintenance workload.

From coordinated management perspective, down hole operation of mining has unstable transmission signal, signal loss situation occurs frequently, therefore it is difficult to carry out coordinated management of groundwater pollution caused by mining. 5G network should fully cover on and under ground, and the intelligent technology is introduced into emergency risk evaluation and rescue of groundwater pollution caused by mining, video communication can be carried out between on and under ground. Monitoring center can carry out emergency risk assessment and rescue of groundwater pollution caused by mining. Relevant personnel can monitor emergency risk evaluation and rescue process of groundwater pollution, therefore coordinated management on and under ground can be achieved, once groundwater pollution risk occurs, corresponding rescue measurements can be taken.

Data mining technology is an important means, which can play role in collecting and analyzing data for achieving 5G communication network optimization. 5G communication network optimization engineering has a large amount of data to be processed, data collection and distribution processing should be implemented regionally for optimizing system. Reasonable data mining technology not only confirm location of site, but also reduce operation cost, and achieve effective integration of resources. this research aims to construct a novel data mining algorithm for improving function of mobile 5G communication network and improving service level of 5G network (Trappey et al., 2023; Qi & Guo, 2022).

4. Remote emergency risk evaluation and rescue system of groundwater pollution based on 5G communication technology

(1) Emergency risk evaluation algorithm

The quality of groundwater resources is an important indicator to measure the degree of pollution. In order to control the pollution of groundwater resources on the premise of maintaining good mining results, relevant organizations have formulated the standard "quality evaluation standard of groundwater resources" according to the ideal geological land subsidence rate.

The so-called quality of groundwater resources includes the evaluation of physical characteristics such as water temperature, transparency, color, smell and taste, as well as the evaluation of chemical characteristics such as gas molecules, element ions, colloidal substances, suspended solids, and the exploration of individual microbial content. On the premise of ensuring that geological land subsidence will not cause serious damage to groundwater

resources, water resources can be classified into five categories according to their specific uses

- Class I: it can be used in the production and processing of various industries and agriculture, and can also be used as domestic water (Masocha et al., 2020);
- Class II: it can clearly reflect the background content of groundwater chemical components, and has a relatively wide range of applications;
- Class III: based on the standard value of drinking water, it is mainly used as drinking water source or industrial and agricultural production water (Zhao et al., 2020);
- Class IV: based on the risk dose value of drinking water, it is mainly used as production water for agriculture and some industries, and can also be used as domestic water after proper treatment;
- Class V: not suitable for drinking water, other water can be selected according to the purpose of processing.

5. Assessment of groundwater pollution in mines

Risk assessment and rescue platform of groundwater based on 5G communication technology is constructed based on groundwater pollution model in mines. The corresponding mathematical models are confirmed.

(1) Groundwater pollution theory

A antimony mining area is used as research objective to carry out emergency risk assessment of groundwater pollution analysis. The total area of the antimony mining area is about 18 km², 12 groundwater monitoring points are set up in the whole mine area, of which 5 are pollution source monitoring points. The basic information of monitoring points is shown in Table 1.

Table 1. Basic information of monitoring points

Number	Type of monitoring points	Notice
1	Pollution diffusion point	Drinking water source
2	Pollution diffusion point	New well
3	Pollution diffusion point	New well
4	Pollution diffusion point	Existing well
5	Pollution diffusion point	Existing well
6	Pollution diffusion point	Existing well
7	Pollution diffusion point	New well
8	Pollution diffusion point	Existing well
9	Pollution diffusion point	Existing well
10	Pollution diffusion point	Existing well
11	Pollution diffusion point	Existing well
12	Background point	Existing well

15 heavy metal indexes including Sb, As, Cd, Hg, Cu, Zn, Pb, Ni, Mo, Co, Se, Cr⁶⁺, Fe, Mn and V were monitored and analyzed. The single component water quality

of groundwater was evaluated, and the single point and single factor pollution index method was used to evaluate the groundwater environmental quality and pollution status. The calculation formula of single factor pollution index method is as follows (Vashist et al., 2020):

$$P_{ki} = (C_{ki} - C_{ki0}) / C_{III}, \quad (1)$$

where P_{ki} is the pollution coefficient of i th index for k th water sample; C_{ki} is the measured concentration value, mg/L; C_{ki0} is background value of i th index for k th water sample, mg/L; C_{III} is the standard limit of class III.

The higher the P_{ki} value is, the higher the pollution degree of groundwater is. The classification basis is shown in Table 2.

Table 2. Classification table of groundwater pollution level

Level	Pollution degree	Range of P_{ki}
I	No pollution	$P_{ki} \leq 0$
II	Light pollution	$0 < P_{ki} \leq 0.2$
III	Medium pollution	$0.2 < P_{ki} \leq 0.6$
IV	Heavy pollution	$0.6 < P_{ki} \leq 1.0$
V	Serious pollution	$1.0 < P_{ki} \leq 1.5$
VI	Extremely heavy pollution	$P_{ki} > 1.5$

Concentration characteristics of heavy metals are shown in Table 3. As seen from Table 3, among the 15 heavy metal indexes of groundwater in the study area, 5 items of As, Sb, Co, Fe and Mn exceed the standard, and the exceeding rates are 15.6%, 62.9%, 53.5%, 15.6% and 11.2%, respectively, and Mn, Sb and Fe have higher exceeding multiple.

Table 3. The concentration of heavy metals in underground water

Index	Over standard rate / %
As	15.6
Sb	62.9
Co	53.5
Fe	15.6
Mn	11.2

(2) Risk analysis and rescue platform of groundwater based on 5G communication technology

5G core network construction of groundwater pollution emergency risk assessment and rescue concludes user plane function/mobile edge computing (UPF/MEC) sink and independent private network.

UPF/MEC sink is a virtue private network that relies on operator communication network to sink operator UPF to mining area or mobile edge node of mining area for deployment, and data can not leave park and delay message forwarding is low. Therefore needs of high bandwidth, delay sensitivity, data confidentiality and other business needs for intelligent emergency risk assessment and

rescue of ground water pollution can be satisfied (Suhaimi et al., 2022). 5G core network framework of UPF/MEC sink means is shown in Figure 1.

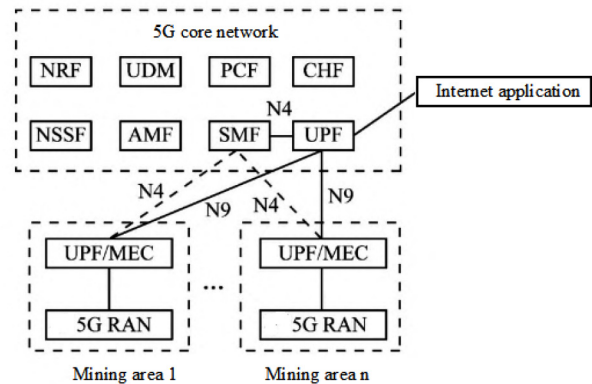


Figure 1. Diagram of UPF/MEC sink

5G core network controlling plane can construct UPF/MEC in mining area based on 5G core network element deployed by operator. 5G virtue private network deployed in UPF/MEC sink means applies public land mobile network for operator network. Base station in mining area chooses 5G core network controlling plane, terminal initiates registration signal process, and base station chooses 5G core network controlling plane of operator. Session management function chooses deployed UPF/MEC based on slice signed by terminal and data network name. Mining area and operator network use same PLMN (Public Land Mobile Network), terminal chooses operator network and mining virtual private network based on slice and DNN (Deep Neural Network), and carries out private network internal forwarding and southbound forwarding for data flow that require to be processed locally to decrease data forwarding delay (Rasheed, 2022).

Independent private network is a mining area dedicated independent core network independently built in coal mine to support 4G and 5G terminal access, which provides network access service for mining area private network users and terminal device. Networking framework of 5G core network in independent private network mode is illustrated in Figure 2.

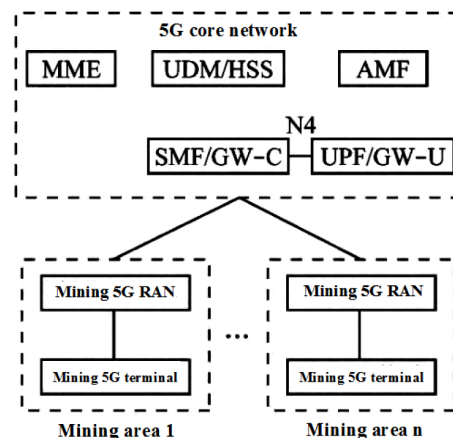


Figure 2. Networking framework of 5G core network in independent private network mode

A set of independent 5G core network is constructed in remote emergency risk assessment and rescue of groundwater pollution caused by mining, which concludes 5G core network control plane and 5G core network user plane, and supports narrowband Internet of Things/4G/5G multiple access means. Base station in mining area (concludes ground base station and underground base station) is set with a unique PLMN for mining area, and after terminal selects this PLMN, registration signaling process is initiated. Base station chooses a dedicated 5G core network independently deployed in mining area based on this PLMN (Silveira et al., 2022).

Groundwater pollution 5G carrier network is similar to the ground 5G carrier network in forward transmission, intermediate transmission and backward transmission. which mainly divided into the carrier network between the 5G core network and the BBU (Building Base band Unit), between the BBU and the RHUB, and between the RHUB and the 5G base station.

(1) Bearer network between the 5G core network and the BBU

According to characteristics of remote emergency risk assessment and rescue of groundwater pollution, F5G is used in this research. F5G has advantages of high bandwidth, massive connection, low delay and zero packet loss, which is composed of passive splitter and optical cable. It uses Type C ring network framework, and supports multiple point fiber break protection, and provides end-to-end protection for optical fibers and equipment in network. and network is more reliable. F5G is a pure medium network, which avoids electromagnetic interference and thunder and lightning. It is extremely suitable for use in places with poor natural conditions and large electromagnetic interference, such as coal mines. At present, F5G has a transmission rate of 10 Gbit/s and a fault protection switching time within 30 ms, which can basically meet needs of 5G applications.

Construction cost of F5G is lower than that of other bearer network. It can get good scalability of network, and has high reliability, and performance index of it satisfies basic needs of 5G bearer network.

(2) Bearing network between BBU and RHUB

RHUB is a centralized controller unit of RF (radio frequency) unit, which realizes the bridge between BBU and Pico RRU. Common Public Radio Interface (CPRI) protocol is adopted between RHUB and BBU, and between RHUB and PicoRRU. User layer data flow, control management layer data flow, and synchronization data flow are transmitted through CPRI interface. Each RHUB can usually connect 8 Pico RRU. To ensure the transmission bandwidth of each Pico RRU, it is necessary to ensure that the transmission between the BBU and RHUB has sufficient bandwidth (Chandra et al., 2022).

(3) Bearing network between RHUB and 5G base station

Peak bandwidth of a typical 5G low frequency single base station reaches 5 Gbit/s, and peak bandwidth of a high

frequency single base station reaches 15 Gbit/s. Since 5G networks currently operated in China all use the 5G FRL low frequency band, 5G base station of remote emergency risk evaluation and rescue of groundwater pollution caused by mining is designed by 5G low frequency band. To ensure wireless performance of base station, 5G single base station adopts 2×10GE/25GE bearer bandwidth. Therefore, CPRI interface is also generally used between RHUB and 5G base station, interface rate is 25 Gbit/s. RHUB and 5G base stations are connected by optical fiber in underground applications, and the maximum pulling distance between them is usually within 2 km (Zhao et al., 2020).

5G base station is main wireless coverage equipment of 5G wireless communication system in remote emergency risk evaluation and rescue of groundwater pollution caused by mining. 5G base station of remote emergency risk evaluation and rescue of groundwater pollution with safety standard certification is generally composed of Pico RRU, supporting power supply, backup battery and supporting antenna. It supports 1-8/2.3/2.6 GHz or 1.8/2.1/3.5 GHz multi frequency concurrent work. It can not only provide high bandwidth 5G NR wireless access, but also be compatible with 4G wireless access, and can also provide wide connection for the Internet of Things in emergency risk evaluation and rescue of groundwater pollution, low rate NB-IoT wireless access. Multiple mode connection of 5G base station of remote emergency risk evaluation and rescue of groundwater pollution offers a technical basis for establishment of an integrated communication network above and below mine. Various underground application scenarios can provide reliable information transmission solutions through the 5G network (Zhao & Song, 2021).

In this research, commonly used 5G base station of remote emergency risk evaluation and rescue of groundwater pollution has four RF ports, and RF output power of each port is 300 mW. To meet needs of transmission threshold power, matching antenna gain is within 8 dBi.

In terms of 5G terminal of remote emergency risk evaluation and rescue of groundwater pollution caused by mining, mining 5G mobile phone, mining CPE (Customer Premise Equipment) and other devices have obtained relevant coal safety certification, and meet the conditions for underground application. 5G mobile phone adopts Android smart phone, which has function of voice call, video call, audio and video return, information collection, remote control and industrial application software installation and application. CPE can achieve conversion of 5G, Wi-Fi and Ethernet signals to meet needs of connecting device with Wi-Fi and Ethernet access functions underground to the 5G network.

6. Case study

In order to verify proposed remote emergency risk assessment and rescue of groundwater pollution caused by mining based on 5G, case study is carried out using a coal mine as researching object. From January 2019 to

Table 4. Concentration of groundwater pollutants in different regions

Number	Ammonia nitrogen pollutant						Average value of P11	Average value of sulfate concentration	Average concentration of lead
	Standard value	Maximum value	Minimum	Average value	Detection rate	Over-standard rate			
1	0.5	0.13	0	0.05	85	0.6	6.53	2.32	0.0003
2	0.5	0.22	0	0.06	82	3.4	6.24	2.22	0.0001
3	0.5	0.26	0	0.08	84	2.5	6.52	16.22	0.0004
4	0.5	0.32	0	0.09	95	2.6	6.73	14.38	0.0005
5	0.5	0.44	0	0.10	94	3.2	6.61	10.53	0.0003
6	0.5	0.56	0	0.12	91	2.1	6.10	8.54	0.0002
7	0.5	0.63	0	0.11	89	0.5	6.37	9.53	0.0004
8	0.5	0.41	0	0.08	90	1.5	6.25	11.42	0.0005
9	0.5	0.36	0	0.06	86	1.2	6.44	7.43	0.0003
10	0.5	0.28	0	0.04	83	0.5	6.62	6.93	0.0006

December 2021, sampling and monitoring were conducted once a month at 10 regions, and the test results are shown in Table 4.

In addition, traditional communication network is also used to carry out performance analysis, performance parameters of different networks are listed in Table 5.

Table 5. Performance of different networks

Number	Performance parameter	Traditional communication technology	Proposed 5G communication system
1	Time delay	65 ms	43 ms
	Packet loss rate	18.7%	2.5%
2	Time delay	62 ms	46 ms
	Packet loss rate	17.7%	3.2%
3	Time delay	68 ms	43 ms
	Packet loss rate	18.8%	3.6%
4	Time delay	68 ms	43 ms
	Packet loss rate	18.8%	3.6%
5	Time delay	69 ms	44 ms
	Packet loss rate	17.2%	2.9%
6	Time delay	76 ms	52 ms
	Packet loss rate	16.8%	3.1%
7	Time delay	89 ms	55 ms
	Packet loss rate	18.3%	3.4%
8	Time delay	73 ms	47 ms
	Packet loss rate	16.9%	2.6%
9	Time delay	89 ms	54 ms
	Packet loss rate	19.5%	3.8%
10	Time delay	77 ms	41 ms
	Packet loss rate	18.3%	3.3%

As seen from Table 5, proposed remote emergency risk assessment and rescue of groundwater pollution has less time delay and packet loss rate, therefore proposed emergency risk assessment and rescue of groundwater pollution has better communication performance.

The assessment results of groundwater environmental quality in the study area are shown in Table 6.

Table 6. The concentration of heavy metals in underground water

Number	Assessment results of pollution status	
	Normal water period	Wet season
1	No pollution	Serious pollution
2	Extremely heavy pollution	Extremely heavy pollution
3	Extremely heavy pollution	Extremely heavy pollution
4	Extremely heavy pollution	Medium pollution
5	No pollution	No pollution
6	Extremely heavy pollution	Extremely heavy pollution
7	Extremely heavy pollution	Extremely heavy pollution
8	Extremely heavy pollution	Extremely heavy pollution
9	Extremely heavy pollution	No pollution
10	Extremely heavy pollution	Extremely heavy pollution
11	Extremely heavy pollution	Extremely heavy pollution
12	Extremely heavy pollution	No pollution

The groundwater quality in the study area is relatively poor in normal water period, and 10 of the 12 monitoring points are extremely polluted. In the wet season, the groundwater pollution is relatively light, 7 monitoring points are extremely polluted, 3 monitoring points are not polluted, 1 is medium pollution and 1 is serious pollution. Therefore, it can be seen that the concentration of main pollutants in groundwater in the study area is directly affected by the change of groundwater volume, and the pollutant concentration is generally low in the wet season. According to remote emergency risk assessment results, corresponding rescue countermeasures can be taken timely for avoid groundwater pollution caused by mining. Results show that the proposed remote emergency risk assessment and rescue of groundwater pollution caused by mining based on 5G can obtain good effect, the main reason for this situation is that the proposed data mining algorithm can effectively cope with data of 5G communication network, and evaluation correctness is improved.

With the deepening of groundwater pollution caused by mining, the government has carried out strict rectification work on groundwater pollution caused by mining.

Groundwater pollution not only has an important impact on the lives and properties of the surrounding residents, but also has an important damage to the ecological environment around the mine, which seriously affects the stability of the local ecosystem. The environment is the basis of economic construction foundation. In order to reduce the impact of mining on groundwater resources, the problem of groundwater pollution caused by mining is studied in order to reduce the impact of mining on groundwater.

In order to fundamentally solve the pollution of groundwater in the process of mining, we should first use legal means to strictly restrict the behavior of relevant personnel in the mining process, so as to avoid the occurrence of bad behavior. In the process of mining, governments at all levels should strictly review the mining procedures in accordance with the national laws and regulations, so as to reduce the pollution of groundwater resources in the process of mining (Howladar et al., 2017). At the same time, when examining and approving the mining projects, the governments at all levels should take the environmental monitoring reports in the process of mining as the key basis for approval, and only when the mining enterprises meet the requirements of the environmental monitoring reports can the mineral projects be approved. In the mining engineering, in order to minimize the pollution of groundwater resources, we should provide a reasonable way to mine resources.

In the main factors of groundwater pollution, a large part is caused by human factors. Therefore, in the mining process, it is necessary to establish the awareness of "saving water" to reduce the impact of mining on groundwater system. For mining companies, it is necessary to cultivate staff's awareness of water-saving and control the discharge of polluted waste-water. At the same time, mining companies should introduce more advanced environmental protection and energy-saving equipment to recycle the waste generated in the mining process. For some objects that cannot be recycled, they can only be discharged after reaching the discharge standard after corresponding treatment, so as to realize sustainable development concept.

The government has the responsibility to satisfy the people's right to know about the groundwater pollution caused by mineral exploitation. The real-time detection of groundwater quality and the release of relevant data to the public are the responsibility of the government. In recent years, more and more media have exposed the groundwater pollution, which also reflects the problem that the government does not monitor the groundwater condition in place. It is suggested that groundwater monitoring stations should be set up scientifically according to the mining area, real-time detection and publication to the public. The release of PM2.5 data can be taken as the best example.

Mineral mining enterprises should closely monitor the production system, discover and deal with the leakage of pollutants in time. Mining enterprises should strictly manage the existing equipment and technology, strengthen the monitoring of weak links that are prone to pollutant

leakage, and strengthen the management of leakage, emission, dripping and leakage, and timely discover and take measures to eliminate or control groundwater pollution, environmental benefits have been achieved.

In the mining of mineral resources, for the weak units which are easy to cause the leakage of pollutants, we should establish the responsibility system for the prevention and control of groundwater pollution. The enterprise leaders should pay attention to the prevention and control of groundwater pollution ideologically, put the task on the same position as the production work and safety work, and make necessary arrangements, evaluations, rewards and punishments.

The emergency assessment and rescue platform for coal mine water pollution based on 5G technology has the characteristics of integrity, stability, and environmental adaptability. It enriches the theoretical framework for the assessment and emergency rescue of sudden water pollution accidents in coal mine areas, enriches the theory of emergency rescue management, enhances the emergency rescue capabilities of coal mines to deal with sudden water pollution accidents, and has certain theoretical and practical significance for the development of coal mine production and the protection of water environment.

7. Conclusions

The influence and pollution of underground water caused by mining has aroused widespread concern of the society. A series of vicious circle has seriously affected people's normal life and even affected the development of the whole society. Therefore, it is particularly important to take certain protection measures for groundwater resources in the process of mining. To cope with this problem, a remote emergency risk assessment and rescue of groundwater pollution caused by mining based on 5G communication technology is constructed. Simulation results show that proposed wireless system has better communication performance. Proposed data mining algorithm can effectively cope with data of 5G communication network, and evaluation correctness is improved. Policy recommendations are provided for mining enterprises. For mining enterprises, it is necessary to improve mining technology, make use of the advanced nature of new and high technology, ensure the smooth completion of construction work, guarantee groundwater quality and realize the rational utilization and sustainable development of water resources. Improved data mining algorithm should be developed for optimizing 5G communication network.

Authors contributions

Jiandong Zhang: writing; supervision.

Disclosure statement

There is no competing interests in this paper.

Availability of data and materials

The data used to support the findings of this study are available from the corresponding author upon request.

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