IOP Conference Series: Earth and Environmental Science

PAPER • OPEN ACCESS

The hazard of change landscape and hydrogeology zone south karst mountain impact natural and human activity in Region Jember

F A Ikhsan[1], S Astutik[1], S Kantun[1] and B Apriyanto[1]

IOP Conference Series: Earth and Environmental Science, Volume 243, conference 1

Article PDF

References

+ Article information

Abstract

The purpose of this study was to determine the hazard of landscape change and hydrogeology in the karst region of the southern mountains of Jember Regency due to natural processes and human activities. The method used in this study used inductively on karst areas of the southern mountains. This method is used to determine the nature of diffuse, fissure, and conduit flow. In addition, hydrograph flow is used to determine the conditions of water release and karst squamous conditions with parameters related to natural changes and human activities. The hydrochemical properties and flow properties are used to characterize karst aquifer conditions in the southern mountains of Jember region. The results showed that landscape and hydrogeological changes in the karst area experienced rapid dissolution. Throughout the year the flow conditions of karst hydrology in the Jember area were dominated by diffuse and conducit types, so that fissure conditions never occurred. In addition, the hydrochemical conditions in the karst area did not experience sharp fluctuations between the base flow and DHL regarding dissolution in karst hydrology. The dominance of human activities includes traditional mining and the establishment of puger cement factories in the southern Karst mountain zone, which affects natural and hydrogeological changes naturally as a result of the opening of karst land for industrial raw materials.

References

[1] Adji TN 2010 Spatial and Temporal Variation of Hydrogeochemistry and karst Flow Properties to Characterize Karst Dynamic System in Bribin Underground River Gunung Kidul Regency DIY Province Jawa Indonesia *Summary Dessertation in Geography Study Program Graduate School of Geography Gadjah Mada University Yogyakarta*
Google Scholar

[2] Adji TN 2011 Diffuse flow of Upper Brick River Rainfall Capture Area at Cave Circle of KarstGunung Sewu Gunung Kidul Yogyakarta *Jurnal Geologi Indonesia* **6**
Google Scholar

[3] Muhammad Arsyad, Hidayat Pawitan, Paston Sidauruk and Putri Eka Intan Kumala 2014 Analysis of Availability of Underground River Water and Sustainable Use in the Karst Maros Region of South Sulawesi *Journal Human and Environment* **21** 8-14 Maret 2014
Google Scholar

[4] Michel Bakalowics 2005 Karst Groundwater: a challenge for new resources *Journal Hydrogeology* **13** 148-16
Crossref Google Scholar

[5] Etimi R 2005 Use Hydrochemical Studies to Identify the Recharge Sources of Karst Spring example of Poceme Springs in Albania *Geophysical research Abstracts* **7** 04063
Google Scholar

[6] Ford and Wiliams 1996 *Karst Geomorphology and Hydrology* (London: Chapmand Hall)
Google Scholar

[7] Ford DC and Williams P 2007 *Karst Hydrogeology and Geomorphology* (London: John Wiley and Sons)
Crossref Google Scholar

[8] Guntarto 2003 Direction of Environmental Geology for Land Use in Karst Region of Gunung kidul Regency Yogyakarta Special Region *Buletin Geology Environmental* **13** 101-109
Google Scholar

[9] Kiernan K 2010 Environmental Degradation in Karst Areas of Cambodia: A Legacy of War? *Jounal Land Degradation & Development* **21** 503-519
Crossref Google Scholar

[10] Meixian Liu, Xianli Xu, Dingbo Wang, Sun Alexander Y and Kelin Wang 2016 Karst Catchments Exhibited Higher Degradation Stress from Climate Change than the Non Karst Cathments in Southwest China: An Ecohydrologycal Perspective *Journal Hydrology* **535** 173-180
Crossref Google Scholar

[11] Loczy D 2006 International Review of Karst Vulneability Rating Menthods *Karst development* **16** 209-221 in Hungarian
Google Scholar

[12] Moga J and Horvath G 2004 The Viewpoint of the Indication of the Surfae Protection Areas Connected to Caves *Horcarth G Soil Effect on Karst Processes University Busdapest Hungaria* 89-106
Google Scholar

[13] Mogajanos *et al* 2013 Hazards and Landscape Chaanges (Degradations) on Hungarian Karst Mountains Due to Natural and Human *Jounal Springer* **10** 16-2
Google Scholar

[14] Nemeth J 1998 *The Methods of the Biological Water Qualification* (Budapest hungary: KGI Press) 303
Google Scholar

[15] Parise M and Pascali V 2003 Surface and Subsurface Environmental Degradation in The Karst of Apulia (Southern Italy) *Environmental geology* **44** 274-256
Crossref Google Scholar

[16] Junbing Pu, Cao Min Zhang Yuanzhu, Daoxian Yuan and Heping Zhao 2013 *Hydrochemical Indications of Human Impact on Karst Groundater in Subtropical Karst Area Chonging China* (Berlin Heidelberg: Springer-Verlag)
Google Scholar

[17] Sener E, Davraz A and Ozcelik M 2005 An Integration of GIS and Remote Sensing in Grounwater Investigations: a case study in Burdur Turkey *Journal Hydrogeology* **13** 826-834
Crossref Google Scholar

[18] Taminskas T and Marcinkevicius V 2001 Karst Geoindicators of Environmental Change: The Case of Lithuania *Journal Environmental Geology* **42** 757-766
Google Scholar

[19] Tesfaye TG 2010 Groundwater Potential Evaluation Based on Integrated GIS and Remote Sensing Techniques in Bilate River Catchment: South rift valler of Ethiopia Masther thesis Addis Ababa University School of Graduate Studies Department Earth Sciences
Google Scholar

[20] Wang Ma T and Luo Z 2001 Geostatistical and Geochemical Analysis of Surface Water Leakage into Groundwater on a Regional Scale: a case study in the Liulin Karst System Nortwestern China *Journal of Hydrology* **246** 223-234
Crossref Google Scholar

PAPER • **OPEN ACCESS**

The hazard of change landscape and hydrogeology zone south karst mountain impact natural and human activity in Region Jember

To cite this article: F A Ikhsan *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **243** 012036

The hazard of change landscape and hydrogeology zone south karst mountain impact natural and human activity in Region Jember

F A Ikhsan[1], S Astutik[1], S Kantun[1], B Apriyanto[1]
[1]Department of Geography Education, University Jember, Indonesia

Email: Ahwan.fkip@unej.ac.id.

Abstract, The purpose of this study was to determine the hazard of landscape change and hydrogeology in the karst region of the southern mountains of Jember Regency due to natural processes and human activities. The method used in this study used inductively on karst areas of the southern mountains. This method is used to determine the nature of diffuse, fissure, and conduit flow. In addition, hydrograph flow is used to determine the conditions of water release and karst squamous conditions with parameters related to natural changes and human activities. The hydrochemical properties and flow properties are used to characterize karst aquifer conditions in the southern mountains of Jember region. The results showed that landscape and hydrogeological changes in the karst area experienced rapid dissolution. Throughout the year the flow conditions of karst hydrology in the Jember area were dominated by diffuse and conducit types, so that fissure conditions never occurred. In addition, the hydrochemical conditions in the karst area did not experience sharp fluctuations between the base flow and DHL regarding dissolution in karst hydrology. The dominance of human activities includes traditional mining and the establishment of puger cement factories in the southern Karst mountain zone, which affects natural and hydrogeological changes naturally as a result of the opening of karst land for industrial raw materials.

1. Introduction

The southern mountainous zone is one of the karst regions extending from the southeast to east of Yogyakarta Province along the East Java coast. Ford and Williams [6], explained that karst has characteristic, relief, and typical drainage caused by intensive rock dissolution. Changes in the karst area can occur due to natural processes and human activities as indicators in the landscape and environmental landscape change process and hydrogeology for karst springs. Anthropogenic and antopogenic processes can cause considerable landscape degradation [6,11,15]. Faster changes from the karst area are more to human activities in land clearing activities.

The southern region of Jember Regency is almost entirely dominated by karst which has limestone forms. [8] Stated that the karst area is susceptible to physical changes that can change the entire area component itself. Changes in the karst area that occurred in the southern mountain zone of Jember district were damaged due to the dissolution of climate change, mining, agricultural activities, and human settlements. All of these components cause a decrease in the environmental carrying capacity of the Jember Karst region. Mining activity causes a lot of changes in the karst landscape in a space and ecological manner.

The beginning karst mountains sadeng was still covered with vegetation and over time changed barren land without vegetation which resulted in natural and regional conditions changing. Population activities can affect ecosystems in karst areas both organically and inorganically. The content of organic matter has the effect of chemical and physical processes affecting soil fertility in the karst area. Vegetation logging activities, covered stripping, limestone excavation, covered land stockpiling and construction of mining facilities have the potential to change the physical condition of zone karst This change resulted in the formation of the zone karst as the main regulator in the region hydrological system. The process of dissolving and storing more water in cavities from hills and epicars. The karst hill is very important for water storage and carbon dioxide storage zones. The

dangers of agricultural activities, deforestation, settlement expansion, and mining for building materials increase the change in the karst landscape which is quite large [12].

The availability of water in the karst area is very dependent on the amount of water discharge in the rainy and dry season [3]. The principle that the karst aquifer layer has three characteristics, namely (1) the flow of the passageway; (2) gap; and seepage. The type of seepage flow is the most common flow in the karst zone of the southern mountains of the Jember region of East Java Province. The pattern of release water flows and aquifers can differentiate form flow in the karst region. The application of inductive methods combined with karst springs can categorize the structure of aquifers in the karst area [1,5,20]. The soil aquifer structure in the karst area greatly affects the absorption rate and water quality.

The southern mountain karst zone experiences rapid land changes due to trench and doline erosion. The high intensity of rainfall in Jember Regency affects the dissolution process in addition to human activities. Excessive use of landscape is very dangerous to the environment and society as a whole. Natural factors (weather, geology, morphology, and hydrology) and human activities in an integrated manner influence the landscape landscape conditions and hydrogeology of the mountain sadeng karst area in Jember Regency. Complex problems of the puger karst phenomenon have their own characteristics compared to other regions in the south of Java. The study that became the focus of this study on geomorphological studies of karst land and hydrology of the southern mountains, especially mountains sadeng.

2. Method

The research method used with direct observation and measurement in the field. Investigations include environmental abiotic elements which include soil, soil erosion, changes in the quality and quantity of karst water, contamination of karst springs, and land cover factors that affect surface water quality by labeling [14]. Groundwater potential is carried out by evaluating the spatial relationship according to the distribution of groundwater locations by optimizing the hydrogeological extraction factors according to the field survey [17,19]. Data collected in the study include:

1. Chalk miner data on Mountains Sadeng.
2. Water level data of the karst area collected automatically and recorded for 15 minutes.
3. The water discharge data of the karst area is measured directly in the field according to the location and value of DHL for 10 seconds.

The data processing techniques in this research :

1. Knowing the nature of the karst puger aquifer
   - Determination of flow discharge by stage-discharge rating curve

   Stage-discharge rating curve is a curve that shows the relationship between water level and discharge in a flow. This method is used with different times which are represented by a scale between water level data on the vertical axis and discharge data on the horizontal axis
   - *Baseflow separation*

   Flow separation is done to find the value of the recession constant in the hydrograph throughout the study.
2. Hydrogeochemical conditions of the karst puger aquifer
   - Test water quality laboratories

   The composition of the chemical content in water Ca2 +, Mg2 +, Na +, K +, HCO-3, SO42-, and CI- is used to determine water quality in the karst puger area.
   - Determination of the type of water chemistry

   Determination of chemical conditions includes dominant anions and cations in water samples from the karst puger region.
3. Relation of flow characteristics to describe the Characteristics hydrogeochemical conditions of the karst aquifer

   Processing of data collected to determine hydrogeochemical conditions was carried out by making scatter plots using statistics that were used to determine the nature of chemical flow with hydrogeochemical conditions during karst hydrogeological research which included: (1) flow discharge with a basic percentage; (2) Flow discharge with the content of HCO-3; (3) DHL with the content of Ca2 + and HCO-3; (4) Percentage of base flow with the content of HCO3-.

Data analysis techniques used to determine the hydrogelogical conditions of karst mountains sadeng include the nature of aquifer flow and hydrochemistry including:

1. Regression Analysis
   Regression analysis was used to change the water height data in the karst puger area with curvature that connected the water level height variable with the discharge variable obtained from direct measurements in the field including the characteristics of the hydrocemograph.
2. Descriptive Analysis
   Description of the nature of the karst aquifer flow was carried out by descriptive analysis of recession values and percentage of flow.

3. Results and Discussion

Changes in the mountains sadeng karst landscape in Jember Regency are caused by traditional industrial and mining activities. The establishment of a cement factory in the Puger karst area has had a rapid impact on landscape, space and ecological changes. These changes affect hydrological conditions both for surface and underground water for the surrounding community. Other impacts of mining activities are more on the quality of the environment and ecosystems for the lives of the population. Company data and the amount of lime mined by mining companies are as follows:

Table 1. The Number of Results Exploration Chalks from Mount Sadeng

Name Industry	Number of Lime mined (Tons Per Year)
CV Sari Hutan	6.597
CV Mada Karya	28.623
PT USPRI	37.935
PT Pertama	62.150
CV Formitra	5.000
CV Kemuning	846
CV Indolime I	9.313
CV Indolime II	401
CV Widya Utama	1.248
PT Semen Puger Jaya	540.000

Source: Research Data Primer, 2018

The karst landscape that has changed at mount sadeng is also caused by traditional mining. This activity was carried out to improve the economy, especially for the people in the Puger District of Jember Regency. The form of mining is more processed to be a mixture of buildings. Traditional mining is more individualized from various villages. Data on the number of traditional miners in the mountains sadeng karst area are as follows:

Table 2. Number of Traditional Karst Miners on Mount Sadeng

Origin of Miners	**Number of People**
Grenden Village	98
Kasiyan Village	19
Puger Kulon Village	22
Puger Wetan Village	36
Total Amount	175

Source: Research Data Primer, 2018

The form of karst mining activities causes a lot of environmental problems in particular. Ex-mining has become unusually damaged and damaged. The following is a picture of karst damage on Mount Sadeng Puger, Jember Regency:

Figure 1. Location Changes Landscape Karst Mountain Sadeng

The heaviest damage in the field occurred in locations I and II. Both locations are industrial estates with large scale cement plants. While locations III and IV the damage level is still small. This condition is inseparable from traditional mining activities carried out by residents living in four villages including grenden, kasiyan, puger kulon, and puger wetan.

Damage at some points of the mountain sadeng karst location has affected specific hydrogeological conditions. Following are the results of measurements of the composition of water samples in the karts area:

Table 3. Chemical Composition of Water Samples in the Mount Sadeng Region

Time	DHL (umho/cm)	pH	Temperature (^{0}C)	Ca^{2+} (epm)	HCO_2^-	SO_4^{2-}	Debit (s)	Basic flow (%)
11/08/2018	554	6.93	27.00	6.69	7.08	0.06	2.27	80.06
18/08/2018	569	6.5	26.40	6.99	6.40	0.04	2.24	80.00
25/08/2018	568	7.02	26.3	5.74	6.60	0.06	2.51	80.07
08/09/2018	567	6.3	26	8.48	5.11	0.06	2.30	80.17
15/09/2018	444	6.2	25.7	6.24	4.92	0.06	2.11	80.04
22/09/2018	558	6.0	25.7	6.79	7.60	0.02	2.23	73.74
29/09/2018	598	7	25.9	5.61	7.08	0.02	2.38	80.06

Source: Field Measurement and Laboratory Analysis, 2018

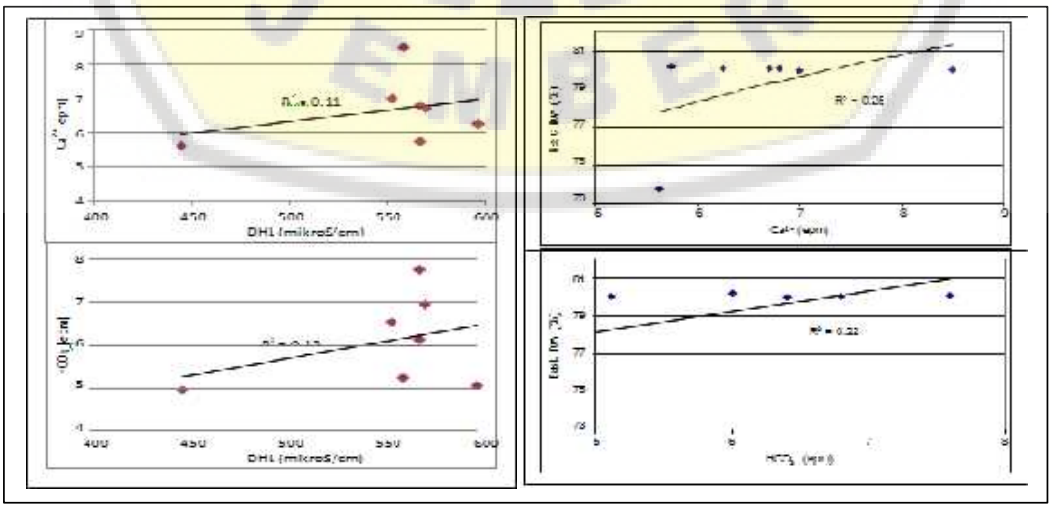

Figure 2. Dominant Element of Dissolution and DHL Water Flow in Mountains Sadeng Karst

The results of the analysis showed that the dominant element that dissolves in the soil aquifer flow system is the element Ca2 + and HCO2-. Both elements dissolve easily considering the extraordinary land clearing for industrial activities, especially at location points I and II. On the other hand the strength of the lower water flow is stronger around 22% to 25%. Hydrograph conditions indicate the acceleration of underground water flow as a result of the dissolution of elements from mountains sadeng karts. The acceleration can be seen in the following picture:

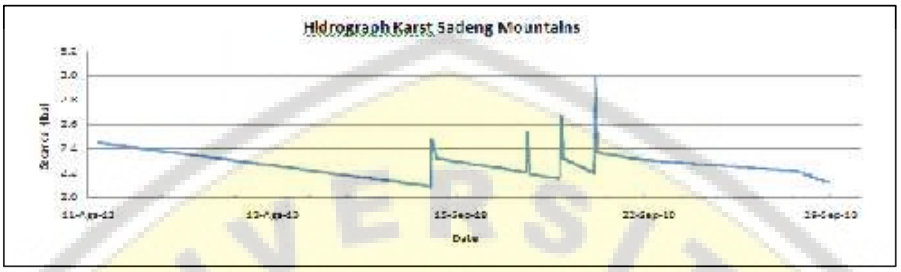

Figure 3. Speed of Under Water Discharge Mountains Sadeng Karst

The based on research data changes in Mount Sadeng karst landscape caused geomorphological, ecological and ecosystem degradation in space and region. Changes in landscape shape are influenced by political policies and mining issued by the government. This is indicated by the operation of a high capacity cement plant in the area around Mount Sadeng. All traditional industrial and mining activities trigger damage with the aim of strengthening the regional economy.

The process of regional development has transformed nature into a new form of space. Gunung Sadeng karst exploration not only changes the geomorphological form, but also affects the hydrogeological conditions of groundwater flow. The influence of climate and hydrological conditions affect the rate of chemical denudation and land damage as indicators and discussions of changes in the karst environment [18]. Damage to karst land triggers increased erosion activity as a result of opening vegetation through licensed and traditional mining activities. Emphasizes that increasing exploration of karst hills from human activities can lead to increased soil erosion and severe, widespread and all-time environmental damage [9].

Industrial investors and traditional miners in their applications do not have knowledge that is responsive to ecohydrology and changes in karst land, especially in the climate aspect. The contribution of climate change is very important in managing water resources and ecological protection of karst land. Mining triggers negative impacts in the process of dissolution and absorption for surface water. Changes in evatranspiration in the karst area are more sensitive to changes in rainfall. This shows that human activity can change evapotranspiration for watersheds and rivers which cause high karst degradation [10].

The changes of the karst space and passageways can change the hydrochemical composition and hydrogeology of the water flow structure. Hydrochemical composition is useful for evaluating water quality problems that cause chemicals to be insoluble in karst aquifers. The parameter is difficult to distinguish hydrochemical changes from natural and human activities. This is supported by findings that the condition of water isotopes is measured by sources with parameters of rainwater, groundwater, and the amount of waste from human activities in urban areas [16].

The change of karst landscapes give rise to new landforms in mount sadeng such as lakes, changes in vegetation, and landslides. The danger of landscape change and karst hydrogeology has increased specifically due to human activities. Forms of landscape change and human activity have different effects from each karst place in the southern mountain zone. The differences in place, location, weather and climate, the quality of land cover, and the utilization investigated are strongly influenced by the characteristics of regional characteristics. The karstological processes in karst ecological systems occur due to rapid new geomorphological processes (trenches, landslides, collapsed, and new sinkholes) as a tangible form of the effects of climate change [13]. The impact is that the water flow is more open and difficult to distinguish between surface and underground water. The type of open flow formed diffuse type. This finding is fundamental aspect of the investigation of

karst hydrology is practically related to the water storage capacity of the aquifer layer which is useful for predicting vulnerability in the productive zone [4].

4. Conclucion

Changes to the power's karst landscape in the Jember area were damaged due to the traditional activities of illegal mining and the establishment of a cement factory. These activities affect space conditions in human interaction with the environment. Increased degradation of karst space has affected the condition of vegetation growth and hydrogeology of land in the region. The results of hydrogeological analysis indicate that the type of water flow in the aquifer is of the *diffuse type*. These findings indicate that the condition of the land aquifer has not developed despite land degradation. The measurement of the water flow structure does not show sharp fluctuations, resulting in a strong relationship between the base flow and DHL. The puger karst hydrology system is open, which is shown by the strong relationship between the base flow and the pressure of carbon dioxide gas due to mining and changes in karsts land.

Acknowledgment

We thanks to all participants voluntarily. We also thanks to people who helps us in finishing the paper.

Reference

[1] Adji TN 2010 Spatial and Temporal Variation of Hydrogeochemistry and karst Flow Properties to Characterize Karst Dynamic System in Bribin Underground River Gunung Kidul Regency DIY Province Jawa Indonesia *Summary Dessertation in Geography Study Program Graduate School of Geography Gadjah Mada University Yogyakarta*

[2] Adji TN 2011 Diffuse flow of Upper Brick River Rainfall Capture Area at Cave Circle of KarstGunung Sewu Gunung Kidul Yogyakarta *Jurnal Geologi Indonesia Vol 6 No 3*

[3] Arsyad Muhammad Pawitan Hidayat Sidauruk Paston dan Putri Eka Intan Kumala 2014 Analysis of Availability of Underground River Water and Sustainable Use in the Karst Maros Region of South Sulawesi *Journal Human and Environment Vol21 No1 Maret 2014: 8-14*

[4] Bakalowics Michel 2005 Karst Groundwater: a challenge for new resources *Journal Hydrogeology 13 148-16*

[5] Etfimi R 2005 Use Hydrochemical Studies to Identify the Recharge Sources of Karst Spring example of Poceme Springs in Albania *Geophysical research Abstracts Vol7 04063*

[6] Ford and Wiliams 1996 *Karst Geomorphology and Hydrology* (London: Chapmand Hall)

[7] Ford DC and Williams P 2007 *Karst Hydrogeology and Geomorphology* (London: John Wiley and Sons)

[8] Guntarto 2003 Direction of Environmental Geology for Land Use in Karst Region of Gunung kidul Regency Yogyakarta Special Region *Buletin Geology Environmental Vol 13 No2: 101-109*

[9] Kiernan K 2010 Environmental Degradation in Karst Areas of Cambodia: A Legacy of War? *Jounal Land Degradation & Development 21: 503-519*

[10] Liu Meixian Xu Xianli Wang Dingbo Sun Alexander Y and Wang Kelin 2016 Karst Catchments Exhibited Higher Degradation Stress from Climate Change than the Non Karst Cathments in Southwest China: An Ecohydrologycal Perspective *Journal Hydrology 535 (2016) 173-180*

[11] Loczy D 2006 International Review of Karst Vulneability Rating Menthods *Karst development 16: 209-221(in Hungarian)*

[12] Moga J and Horvath G 2004 The Viewpoint of the Indication of the Surfae Protection Areas Connected to Caves In: Horcarth G Soil Effect on Karst Processes University Busdapest Hungaria 89-106

[13] Mogajanos etal 2013 Hazards and Landscape Chaanges (Degradations) on Hungarian Karst Mountains Due to Natural and Human *Jounal Springer 10 16-2*

[14] Nemeth J 1998 The Methods of the Biological Water Qualification *KGI Press Budapest hungary p 303*

[15] Parise M and Pascali V 2003 Surface and Subsurface Environmental Degradation in The Karst of Apulia (Southern Italy) *Environmental geology 44: 274-256*

[16] Pu Junbing ,Cao Min Zhang Yuanzhu, Yuan Daoxian and Zhao Heping 2013 Hydrochemical Indications of Human Impact on Karst Groundater in Subtropical Karst Area Chonging China *Springer-Verlag Berlin Heidelberg*

[17] Sener E, Davraz A and Ozcelik M 2005 An Integration of GIS and Remote Sensing in Grounwater Investigations: a case study in Burdur Turkey *Journal Hydrogeology 13 826- 834*
[18] Taminskas T And V Marcinkevicius 2001 Karst Geoindicators of Environmental Change: The Case of Lithuania *Journal Environmental Geology 42: 757-766*
[19] Tesfaye TG 2010 Groundwater Potential Evaluation Based on Integrated GIS and Remote Sensing Techniques in Bilate River Catchment: South rift valler of Ethiopia *Masther thesis Addis Ababa University School of Graduate Studies Department Earth Sciences*
[20] Wang Ma T Luo Z 2001 Geostatistical and Geochemical Analysis of Surface Water Leakage into Groundwater on a Regional Scale: a case study in the Liulin Karst System Nortwestern China *Journal of Hydrology 246 223-234*