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[Integrated-Skill Approach](#), [Perception](#), [Impact](#), [Communicative](#)

[Competence](#) [Learning](#)

[Biology](#) [Malaria](#)

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[Learning Rabies](#) [SARS-Cov-2](#) [Scientific](#) [Sri Lanka](#)

[Stress](#) [Temperature](#)

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FEES #

Home > Archives > Vol 28, No 1 (2021)

Vol 28, No 1 (2021)

DOI: <http://dx.doi.org/10.52155/ijpsat.v28.1>

Table of Contents

Articles

[Mutations Socio-Spatiales Et Extension Urbaine Au Sud Du Plateau De Sakété \(Sud-Est Du Benin\).](#)
Aser Zinsou Simon HONVO, Dr Adrien C. DOSSOU-YOVO, Dr Adrien C. DOSSOU-YOVO

PDF
01-16

[Counseling on The Use of Health Protocols to Prevent The Spread of COVID-19 to Children Through Animated Videos](#)
Ahmad Sammorino

PDF
17-23

[Typologie Des Systèmes De Production Agricole Dans La Dépression D'Isaba \(Sud-Est Du Benin\).](#)
Constant Comlan YEHOUNOU, Bernard FANGNON, Jean LAOUROU

PDF
24-38

[Evaluation Of Smoked Fish Market Trends In The City Of Ngaoundere \(Adamawa-Cameroun\).](#)
Elysée DJEDOUBOUYOM NAME, Elias ABLADAM DARAHALAYE, Nicolas BAYANG HOULI, Juste Philantropie ABEGA, NDODE Herman OKAH-NNANE, Sébastien VONDOU VONDOU, Iya ABDOULLAHI, Clemence Aggy NJEHOYA

PDF
39-49

[Stratégies Endogènes D'adaptation De Production Agricole Dans La Commune De Kalalé Au Nord-Est Du Bénin](#)
Zénabou GOUNOU, Janvier ASSOUNI, Aboubakar KISSIRA

PDF
50-60

[Flipped Classroom Learning System Based on Guided Inquiry on Electrolyte Solution and Nonelectrolyte Solutions for Class X SMA/MA Students](#)
Masni Rahmayanti Gaja, Mawardi Mawardi

PDF
61-65

[Advanced Navigation Control Systems](#)

Navya Arisetty, Naga Saikiranmai Aduri, Guru sankar Duppada, Nikhil Nalamasu, Yoga Balaji Putta

PDF
66-71

[Freight Flows And Transport Costs On The Logistics Corridors Of Uzbekistan](#)

Yusufkhonov Zokirkhan Yusufkhon ugli, Mirzaev Furkat Sobir ugli, Akhmedov Dilmurod Toshpulat ugli, Masodikov Shokhjakhon Ulugbek ugli

PDF
72-78

[Clinical-Functional, Biochemical Characteristics, And Improvement Of Methods Of Treatment Of Dentoalveolar Anomalies In Children And Adolescents With Bronchial Asthma](#)
Gavkharkhon Fazilbekova, Sunnatullo Gafforov

PDF
79-93

[Services Meteo-Climatiques Pour Une Agriculture Climato-Adaptee : Entre Besoins Expresses Et Offres Fournis Aux Producteurs Des Communes De Dassa-Zoume Et Glazoue Au Centre Du Bénin](#)

Firmin O. KOUDERIN, Alix Servais AFOUDA, Talahatou TABOU, Ghislain ZONDJI, Akibou AKINDELE, Ibouraïma YABI, Euloge OGOUWALE

PDF
94-112

[Reinterpreting the Keynesian and Neoclassical Growth Models in Zimbabwe: The History of Economic Thought in Perspective](#)
Shame Mukoka

PDF
113-123

[Validity of Flipped Classroom on Guided Inquiry in Acid and Base Solution](#)
Zildiya Guswita, Mawardi Mawardi

PDF
124-127

[Organizational Agility Maturity Level Of An Airport Operator In Indonesia](#)

PDF
128-132

ISSN:2509-0119

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[The Effect Of Situational Leadership Style And Achievement Motivation On The Organizational Commitment Of Pt Makmur Bintang Plastindo's Employees](#)

Rizki Yuwidarma, Emmy Mariatin, Eka Danta Jaya Ginting

[PDF](#)

133-137



[Perception Of Health Extension Students Towards National Competency Assessment And Factor Associated Among Harar Health Science College Students, Harari Region, Ethiopia](#)

Arif Hussen Jamie

[PDF](#)

138-144

[Validity of Students Worksheet Using Creative Problem Based Learning Model In Physics Learning On Senior High School](#)

Novelia Prima, Usmeldi Usmeldi

[PDF](#)

145-150

[Estimation of Carbon Stock Using NDVI Vegetation Index in Secondary Forest of Gajabuuh , West Sumatra](#)

Novia Novia, Erizal Mukhtar, Wilson Novarino

[PDF](#)

151-155

[The Influence of Using The Chemical Ludo Game as Chemo-Edutainment Media for Redox Reaction Materials and Compound Nomenclature on Learning Outcomes of MA Students](#)

Sri Wahyuni, Iswendi Iswend

[PDF](#)

156-161

[Analyses Of Domestic Water Supply And Demand Using Geography Information System \(GIS\) In Boji-Boji Agbor, Delta State Nigeria](#)

Ejemeyovwi Danny Ochuko, Ideh Matthew Nkem

[PDF](#)

162-191

[Ambiance Climatique Et Prolifération De La Dengue Dans Les Zones À Risques Dans La Commune D'Abomey- Calavi](#)

Abdoul-Ramane ABDOULAYE, Narcisse SARE

[PDF](#)

192-209

[Manipulation in Donald Trump's Nomination Speech 2020 Election from a CDA Account](#)

Rym Ezzina

[PDF](#)

210-215

[The Importance Of Data Mining In Retail Industry](#)

Muminov Ibrokhim Botir Ugli

[PDF](#)

216-223

[Robotic Surgery in Gynecology Critical Review](#)

Maged Naser, Mohamed MN, Lamia H. Shehata, Laila Abdelfattah

[PDF](#)

224-237

[Linkage of Climate and Natural Disasters to Development Potential](#)

Faradiba Faradiba

[PDF](#)

238-243

[Gestion Du Temps Et Son Impact Sur Les Rendements Scolaires Au Benin](#)

Cohovi Flaubert Spartacus TESSY, Albert Jovite NOUHOUAYI

[PDF](#)

244-253

[The Influence of The Use of The Chemical Ludo Educational game On Environmental Pollution Material On The Learning Outcomes of Class VII Junior High School Student](#)

Rini Yulia, Iswendi Iswend

[PDF](#)

254-259

[Enhancing The Ability Of Poultry Farming To Cope With Covid-19 Pandemic Using Lora Internet Of Things Technology](#)

Waheed Muhammad Sanya

[PDF](#)

260-263

[Assainissement Et Gestion Des Eaux Usées Domestiques Dans Quelques Quartiers De La Commune De La N'Sele Dans La Ville De Kinsha](#)

Tridon YANGONGO M.W, MUTAMBEL' HITY S.N., LUAMBA LUA NSEMBO, PWEMA KIAMFU, NDOMBE TAMASALA

[PDF](#)

264-274

[Analyse De L'effet De L'adoption Des Variétés Améliorées De Mais Sur La Rentabilité Economique Et Financière Des Producteurs Au Nord Benin](#)

A. Joski YESSIFOU, A. Servais AFFOUDA, A. Jacob YABI

[PDF](#)

275-289

[Manifestation De La Dynamique Urbaine Dans L'Arrondissement De Hevie](#)

QUENUM Comlan Irené Eustache Zokpénonou

[PDF](#)

290-302

[Efficacité Economique Des Producteurs Du Piment Et De La Tomate Adoptants Les Stratégies D'Adaptation Face Aux Variabilités Climatiques Dans Les Communes De Djougou Et De Tanguiéta Au Nord-Ouest Du Benin](#)

Malick BABAH-DAOUDA, Afouda Jacob YABI

[PDF](#)

303-320

[Language Learners' and Teachers' Perceptions of the Integrated-skill Approach and its Possible Impact on Learners' Communicative Competence](#)

Lubna Khalid Al Dweni, Eman Mustafa Al Shawesh, Ibrahim Ali Ellabiedi

[PDF](#)

321-330

[Design Of Styrofoam Waste Treatment Equipment For Recycling Crafts Industry](#)

Sumar Hadi Suryo, Ari Teliti Wilarsati

[PDF](#)

331-339

[Effect Of Different Mulch Application On Soil Moisture Conservation, Growth And Grain Yield Of Beans Under Semiarid Of Rain Fed Fersiallitic Soil Conditions In Eastern Of Rwanda.](#)

Samuel HITIMANA, Rukangantambara Hamudu, Nkundabashaka Valens

[PDF](#)

340-350

[Researchers' Artificial Intelligence Expert System Rule-Based Decision Making Using Visirule](#)

Ismail Olaniyi MURAINA, Imran Ademola ADELEKE

[PDF](#)

351-358

[Dynamic System Model of Receipt System \(SRG\) Grain Commodities in South Sulawesi](#)

Mardia Mardia, Didi Rukmana, Mahyuddin Mahyuddin, Mardiana Ethrawaty Fachrie, Diah Retno Dwi Hastuti

[PDF](#)

359-369

[Juridical Analysis of Legal Political Construction Management of Regional Assets to Affirm the Principle of People's Sovereignty:](#)

Juridical Analysis of Legal Political Construction Management of Regional Assets to Affirm the Principle of People's Sovereignty:

[PDF](#)

370-377



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PKP|INDEX



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Sciences and Technologies

ANNOUNCEMENTS

ATOM 1.0
RSS 2.0
RSS 1.0

CURRENT ISSUE

ATOM 1.0
RSS 2.0
RSS 1.0

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Username

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[Search](#)

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- [By Issue](#)
- [By Author](#)
- [By Title](#)

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- [View](#)
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- [Benin COVID-19 Competence](#)
- [Coronavirus Covid-19 Development](#)
- [Gender Income](#)
- [Integrated-Skill Approach](#)
- [Perception_Impact](#)
- [Communicative Competence Learning](#)
- [Biology Malaria](#)
- [Pandemic Problem Based Learning Rabies SARS-Cov-2 Scientific Sri Lanka Stress Temperature Validity](#)
- [pandemic](#)

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[Home > Vol 28, No 1 \(2021\) > Faradiba](#)

Linkage of Climate and Natural Disasters to Development Potential

Faradiba Faradiba

Abstract

The extreme climate change that occurred in Indonesia has an impact on increasing the frequency of natural disasters in almost all parts of Indonesia. The frequency of natural disasters that occur also affects the development potential of a region. This study uses 2018 Rural Potential data and the Rural Development Index. This study uses multiple linear regression by looking at the factors of natural disasters on development potential. Natural disaster factors in this study are landslides, flash floods and hurricanes. The results of this study indicate that natural disasters such as landslides, flash floods and tornadoes have an impact on decreasing development potential, respectively, namely 0.76%, 0.85% and 1.18%. Efforts are needed in disaster mitigation both from the government and the community as well as policies related to development by taking into account the frequency of natural disasters that occur.

Keywords

Climate; Natural Disasters; Development

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Linkage of Climate and Natural Disasters to Development Potential

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Abstract—The extreme climate change that occurred in Indonesia has an impact on increasing the frequency of natural disasters in almost all parts of Indonesia. The frequency of natural disasters that occur also affects the development potential of a region. This study uses 2018 Rural Potential data and the Rural Development Index. This study uses multiple linear regression by looking at the factors of natural disasters on development potential. Natural disaster factors in this study are landslides, flash floods and hurricanes. The results of this study indicate that natural disasters such as landslides, flash floods and tornadoes have an impact on decreasing development potential, respectively, namely 0.76%, 0.85% and 1.18%. Efforts are needed in disaster mitigation both from the government and the community as well as policies related to development by taking into account the frequency of natural disasters that occur.

Keywords: Climate; Natural Disasters; Development.

I. INTRODUCTION

The territory of Indonesia is located in a tropical climate area with two seasons, namely summer and rainy season with the characteristics of extreme changes in weather, temperature and wind direction. These climatic conditions supported by relatively diverse surface topography and rock conditions, both physically and chemically, result in fertile soil conditions. On the other hand, this condition can cause several bad consequences for humans, such as the occurrence of disasters such as floods, landslides, forest fires and droughts [1], [2]. Climate change has been recognized as the cause of the increasing frequency of droughts, forest fires, hurricanes, and others [3], [4]

The average annual temperature in urban areas is 3°C higher than in rural areas. The minimum temperature is greater than 1 - 2 °C and the maximum temperature is 1 - 3 °C [5], [6]. This difference depends on the size of the function, the position of the city itself and also the macro-climate of the city. Differences in urban and rural temperatures are caused by differences in energy consumption, absorption of latent exchange, turbulence and turbulence [7], [8]

Urban materials reflect more heat and most of the reflected radiation is also retained by the walls of buildings, roofs, etc. [9], [10]. Besides that, the conductivity of urban materials (concrete, stone, asphalt, etc.) has a very high heat capacity [11], So the sun's heat is stored during the day and released at night. On the other hand, in rural areas where the surface is mostly covered with vegetation which acts as a shield against the heat of the sun [9], [12], at night and during the day the temperature is lower than in urban areas. This is due to the large number of water sources (in wet soil, puddles) so that a lot of heat is used for evaporation and evapotranspiration. The heat stored in the water vapor is known as latent heat [13]. The city is also a source of heat as a by-product of the activities of its inhabitants (industrial, transportation, household and others). In general, the temperature in the city is higher than in the village [14], [15], This difference is higher in calm wind conditions. For example, the contrast between the temperature

in the city of London and the surrounding villages will appear when the wind speed is < 6 m/s and in sunny weather, the temperature difference can reach 6 oC but if the wind speed is > 11 m/s the temperature difference will disappear [7].

One of the causes of natural disasters is its relation to extreme weather. Climate change is not something that can be taken lightly. There are many potential threats of disaster that haunt us if we do not make efforts to overcome them. Along with the development of time and increasing human activities, environmental damage tends to get worse and triggers an increasing number of incidents and intensity of floods, landslides and droughts that occur one after another in many areas in Indonesia [16], [17]. Statistics related to natural disasters are simply unimaginable [18]. Now every second someone is homeless. When compared, the number of people who have lost their homes due to natural disasters is 3-10 times greater than due to war and conflict. Each year, since 2016, an average of 26 million people have become homeless. This figure is equivalent to one person having to evacuate every second. In 2018 more than 17.2 million people were displaced by natural disasters in 125 countries and territories[19].

The implementation of national development does not always run smoothly, because in its implementation there are many problems that become obstacles. In addition to human resources, there are several factors that hinder development, one of which is natural disasters. With the frequency of occurrence of natural disasters that occur more frequently, of course, development will be hampered. Although development in Indonesia has been designed and designed in such a way with minimal environmental impact, the development process still causes environmental and ecosystem damage [20]. Development that has been based on the exploitation of natural resources (especially on a large scale) has caused the loss of the carrying capacity of these resources to the lives of the people [21]. From year to year forest resources in Indonesia are decreasing, meanwhile the exploitation of mineral resources also causes damage to ecosystems which physically often causes an increase in disaster risk [22], [23].

On the other hand, the pace of development has resulted in increased public access to science and technology [24]. However, due to the lack of precise technology implementation policies, technology failures often occur which have fatal consequences such as transportation accidents, industry and disease outbreaks due to higher human mobilization [25]. Another potential disaster that is no less serious is the factor of demographic diversity in Indonesia [26].

II. METHODS

The data used in this study are raw data from the 2018 PODES data collection and Rural Development Index data. This research uses multiple linear regression method. Multiple linear regression analysis is a linear relationship between two or more independent variables (X_1, X_2, \dots, X_n) with the dependent variable (Y). then the data used is usually an interval or ratio scale. The use of this method is to determine the effect of natural disasters: landslides, flash floods, and hurricanes/typhoons on development potential. The models that will be formed in this research are as follows.:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n \quad (1)$$

III. RESULTS AND DISCUSSION

From the results of this study obtained the effect of natural disasters, namely landslides, flash floods and hurricanes / typhoons on development. From the results of this study, each relationship is presented in table 1, namely the effect of landslides on development, table 2, the effect of flash floods on development, and table 3 the effect of tornadoes on development..

TABLE I. EFFECT OF LANDSLIDES ON DEVELOPMENT

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]
0	63,267	.0754874	.0005071	.1275392	.0744935 .0764812
1	8,969	.067874	.0012186	.1154063	.0654853 .0702627
combined	72,236	.0745421	.0004693	.1261205	.0736223 .0754618
diff		.0076134	.0014227		.0048249 .0104019

diff = mean(0) - mean(1) t = 5.3513
Ho: diff = 0 degrees of freedom = 72234

Ha: diff < 0 Pr(T < t) = 1.0000
Ha: diff != 0 Pr(|T| > |t|) = 0.0000
Ha: diff > 0 Pr(T > t) = 0.0000

In Table 1 it can be interpreted that the impact of landslides on development can reduce the potential for increased development by 0.76 percent. Factors that cause landslides naturally include the morphology of the earth's surface, land use, lithology, geological structure, rainfall, and earthquakes [27]. The effect of rainfall in producing landslides is clear, although it is very difficult to explain precisely [28]. This difficulty arises because rainfall only affects slope stability indirectly to pore-water conditions in the slope-forming material [29]. When the intensity of rainfall is high for a long time, causing rainwater to fall and seep into the ground, it will damage the compact and impermeable rock structure. Over time the rock will break and the rock fragments will be carried away by the flow of water so that landslides occur [30].

In addition to natural factors, it is also caused by human activity factors that affect a landscape, such as agricultural activities, slope loading, slope cutting, and mining [31]. Mitigation of landslide risk in very risky areas is carried out by controlling development in accordance with the carrying capacity of the environment. Development control basically aims to avoid a greater risk in the event of a landslide. Land use is also one of the parameters in the calculation of landslide risk. Uncontrolled land use change is a form of human intervention that can increase the risk of landslides. The increasing need for land for settlements, economic activities, or infrastructure due to an increase in population can also increase the risk in the event of a landslide.

TABLE II. THE EFFECT OF FLASH FLOODS ON DEVELOPMENT

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]
0	70,579	.0747365	.0004764	.1265757	.0738027 .0756704
1	1,657	.0662593	.0025698	.1046083	.0612188 .0712998
combined	72,236	.0745421	.0004693	.1261205	.0736223 .0754618
diff		.0084772	.0031343		.002334 .0146205

Based on Table 2, it can be interpreted that the impact of banjir bandang natural disasters on development can reduce the potential score increase by 0.85 percent. Floods can be caused by static natural conditions such as geography, topography, and river channel geometry. Dynamic natural events such as high rainfall, damming from the sea/tidal on the main river, land subsidence and siltation due to sedimentation, as well as dynamic human activities such as inappropriate use of land in floodplains, namely: by establishing settlements on the banks rivers, lack of flood control infrastructure, land subsidence and sea level rise due to global warming [32].

The intensity of rainfall is an important factor to consider when checking the rain conditions during banjir bandang. Rainfall with very high intensity is usually found in convective rainfall. The duration of high-intensity rainfall is another major factor determining flood risk [33]. Floods become a problem during the rainy season, because the carrying capacity of the watershed against the rain that falls is not capable. Climate change that can increase the intensity of rain and changes in land use add to the risk that occurs. Every time we enter the rainy season, several regions and cities in Indonesia experience flooding problems.

TABLE III. THE EFFECT OF HURRICANES/TYPHOONS ON DEVELOPMENT

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	66,027	.0755518	.0004995	.1283535	.0745727	.0765308
1	6,209	.0638048	.0012524	.0986874	.0613496	.06626
combined	72,236	.0745421	.0004693	.1261205	.0736223	.0754618
diff		.011747	.0016736		.0084668	.0150272

```
diff = mean(θ) - mean(1) t = 7.0191  
Ho: diff = 0 degrees of freedom = 72234
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Based on Table 3, it can be interpreted that the impact of natural disasters such as hurricanes/ hurricanes/ typhoons on development can reduce the potential score increase by 1.18 percent. A hurricane or tornado is a vortex of strong winds with wind speeds of 120 km/hour or more that often occurs in tropical areas between the north and south, except in areas very close to the equator, rotating with a longer scale of about 3 – 7 day, it always happens at sea with destructive power reaching thousands of km [34]. Tornadoes are considered as one of the most dangerous types of wind because they can destroy anything in its path.

Extreme weather that occurs on land includes hurricanes, strong winds, heavy rain, heavy rain accompanied by strong winds or lightning, hail, extreme horizontal visibility or extreme air temperatures. Moderate extreme weather that occurs at sea includes tropical cyclones, strong winds, waterspouts, extreme ocean waves, tidal waves, heavy rains, heavy rains accompanied by strong winds and/or lightning, or extreme horizontal visibility.

An increasing trend of tornadoes as the earth's temperature warms. Global warming increases the temperature of sea water so that water vapor is abundant and clouds grow bigger. There is also a change in the atmosphere where the cloud height grows higher. Several locations in Indonesia show an increasing trend of increasing temperatures. The temperature of the earth's surface is increasing, increasing the contrast of warming in some places. This is the cause of the increasing trend of tornado occurrences. Tornadoes occur because there is a temperature contrast at the change of seasons. Densely inhabited areas tend to heat up faster than green areas.

There are six climatic phenomena that cause extreme weather. These include the La Niña phenomenon, the Asian Monsoon wind phenomenon, the Madden-Julian Oscillation phenomenon, the Kelvin and Rossby phenomenon, the phenomenon of warming sea surface temperatures and the phenomenon of cyclone seeds

IV. CONCLUSION

Extreme climate change results in high intensity of rainfall with a long duration, causing the impact of natural disasters such as landslides, flash floods and tornadoes. The impact of landslides on development can reduce the potential for increased development by 0.76 percent. The impact of banjir bandang natural disasters on development can reduce the potential score increase by 0.85 percent. The impact of hurricane/cyclone/hurricane natural disasters on development can reduce the potential score increase by 1.18 percent. Efforts are needed in disaster mitigation both from the government and the community as well as policies related to development by taking into account the frequency of natural disasters that occur

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