International Journal of Innovative Studies in Sociology and Humanities
ISSN 2456-4931 | Open Access | Volume 8, Issue 1, 2023
DOI: https://doi.org/10.20431/2456-4931.080134

The Phenomenon of Desertification: Causes, Consequences and Control Solutions: The Case of the El-Outaya Area in Biskra (Algeria)

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Received: January 11, 2023 **Accepted**: January 23, 2023 **Published**: January 28, 2023

Abstract

Natural phenomenon constitute one of the most important hazards of the 21st century, and the geomorphological risk represented by desertification is one of the hazards that have taken a prominent place in the local and global attention, since Algeria has suffered and continues to suffer from desertification and widening problems.

The area of el-outaya in Biskra was taken as a model for the study because it is a living example of desertification, located directly under the influences of the desert, exposed to wind erosion, sudden rains and significant evaporation and transpiration. It is characterised by the predominance of agricultural and pastoral activity of the population, and suffers today from a degradation of the natural environment as a result of human pressure and misuse of the environment, especially as the land is undergoing agricultural development.

The continuation of this clear retreat of the natural space in the region will result in an exacerbation of the extent of the phenomenon of desertification, it is thus necessary to take preventive corrective measures to fight against this threat to this environment due to the fragility of its ecosystems and to invest rationally its wealth in the respect of sustainable development

Key words: El-outaya - Desertification - Causes - environment – Salinity- Pastures - Vegetation cover - Control.

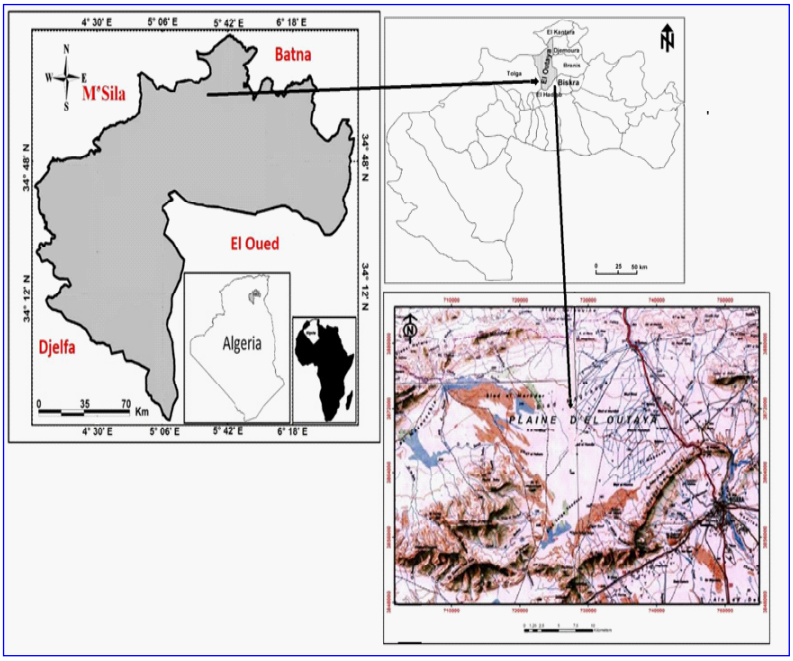
INTRODUCTION

The problem of desertification is one of the urgent environmental problems of our contemporary world, especially in arid and semi-arid environments, but even humid environments characterised by fragile ecosystems have been achieved due to the lack of protection of natural space and the degradation of vegetation cover, where the area of land affected by desertification in the world, in 100 countries, was estimated to be about 3562 million hectares, or 69% of the total area of drylands used for agriculture, and the area of degraded land was estimated to be 1222 million hectares, out of the total grazing land, estimated to be 4546 million hectares, where the resulting loss of land degradation, i.e. the value of lost production in terms of land use, was estimated to be 1.5 billion dollars . And the resulting loss of land degradation, i.e. the value of lost production due to desertification, was estimated at US$ 308 billion, threatening the livelihoods of more than one billion people [1]. The results of the field surveys conducted within the framework of the Land Degradation Early Warning Project indicate that the total degraded areas in the Arab region during the period (1982-2008) amounted to about 658 million hectares, constituting about 47% of the total area of the Arab region. [2]

Algeria is one of the Arab countries concerned by this danger, as more than two thirds of its total area is desert, and the most important threatened areas are the steppes and the margins of the Saharan Atlas, due to the fragile and inconsistent ecosystems, and this is because they have natural and climatic conditions that contribute to the propagation of this phenomenon, as they are subject to a climate characterised by irregular precipitation with great variability in monthly and annual weather, with high temperatures and dry winds[3] In addition to the human factors represented in the poor and intensive exploitation of the field, as the deterioration of the productive and biological capacity of the land is the result of various natural and human factors. [4] Our research focuses mainly on the phenomenon of desertification in the plain of el-outaya in Biskra, which is under the influences of the desert, which is a living example of the emergence of this phenomenon, on which we will work through this study to identify its causes and the factors contributing to its aggravation and how to reduce its magnitude and its prevention.

Location of the Region

The study area is located in the commune of el-outaya, which is north-east of the city of Biskra, the gateway to the desert, 26 km from the national road no. 03 and the railway line linking the city of Constantine and Biskra from north to south, with an estimated area of 409.08 km^2. The commune of el-outaya is administratively attached to the wilaya of Biskra, bordered to the north by the commune of Qantara, to the east by the commune of Al-Baranis and the commune of Tulqa to the west, and the commune of Biskra and the commune of El Hajeb on the south side (See map No. 1)



Map 1. Geographic location commune and plain

The study area is located between two distinct ranges of north and south, it constitutes a morphological and bioclimatic transition area between the Saharan Atlas and the Sahara, where the emergence of two large topographic units is observed represented in the plain region and the mountainous region.

- The plain area is surrounded by mountain ranges, wide on the eastern side and then began to narrow as we head towards the west to occupy a large area where its area reached 330 km^2 and regarding the height from east to west in the range of 240 m and from south to north from 200 to 240 m in the sense that the height of the plain increases as we head towards the north.
- The mountainous region is represented in a closed chain with the plain of el-outayain the middle, and this chain is an extension of the eastern part of the Aures massif, and it is a point of contact with the Amdoukal Mountains, where its height ranges between 400-1031 m, towards the southwest as Mount Hashana 371 m, and the southeastern side is represented in the Zab range, such as Mount Boughazal, 403 m, while the northwestern side is noted by mountains with a medium slope in the southern foothill, such as Mount Bouaref, 758 m.

Desertification, its Causes and Effects on the Medium

The natural characteristics and available climatic conditions make the study area a fragile ecosystem that is rapidly susceptible to any pressure, however limited, on the elements of the vital environment, which may increase the severity of the desertification problem and increase the circle of its spread, given the growing population and excessive and irrational human uses, whether for land or for the pastures and crops found there.

Natural Causes

Natural causes can be summarized in the following elements

Precipitation

The drought and scarcity of rainfall per year enter the region within the semi-desert region, as shown by the data of the

Biskra meteorological station for the period 1994-2017, the annual rate of precipitation ranges between 294.1 mm as the highest value in 2004 and 39.6 mm as the lowest value in 2002 (see the table N°1).

Table 1. variations in annual precipitation in mm during the period from 1994-2017 in both Biskra

2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	**Month**
50	95.1	106.7	45.3	143.5	54.5	282.3	185.5	139.8	118.8	98.8	173	58.8	294.1	159	39.6	88.8	55	190	51	155	153	90	156	**P mm**

Source: Biskra Meteorological Stations,2020

The study of the variation of the monthly average precipitation for the period 1984-2013 shows us a long period of drought. Precipitation reached a maximum value of 21.92 in March and a minimum of 3.31 in August (see the tableN°2).

Table 2. Monthly average precipitation in Biskra 1984-2013

Month	Sep	Oct	Nov	Des	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Total
P(mm)	20.4	15.72	18.34	14.2	13.99	7.54	21.92	17.33	10.34	5.94	6.21	3.31	155.24

Source: Biskra Meteorological Stations,2014

60% to 70% of the amount of rain is confined to the cold season, it comes down in the form of heavy rain to a flood, which makes us describe it as sudden and fluctuating, as oscillation remains the main feature of precipitation in the region, which negatively affects the field, especially in the rainy period when the rains fall quickly and heavily in a short period, which leads to soil erosion and causing torrents and often floods(see the pictures n°1-2) .

Pictures (1, 2). The effect of water erosion in the area of Idris Omar,el-outaya

Temperature

In light of the data of the Biskra station (see the table N°3), the temperatures are as high as34.5 ° C in the month of July, when the lowest reaches a value of 12.01° C in January, during the period 1994-2017 and from these values is clear the great thermal variation or what is expressed by the thermal range that characterizes the dry continental areas, and the large difference in temperatures between night and day and expressed in the daily thermal range makes the latter high, which works to shrink and expand rocks and thus fragmentation and ease of transport by Wind i.e. wind erosion.

Table 3. Monthly temperatures in mm during the period from 1994-2017 in both Biskra

Month	Sep	Oct	Nov	Des	Jan	Feb	Mar	Apr	May	Jun	Jul	Au
avg C°	29.01	23.45	23.45	13	12.01	13.55	17.17	20.22	26.04	31.22	34.5	34

Source: Biskra Meteorological Stations,2020

Evaporation

Evaporation is an essential element in determining dry areas, drought determines climatically if the annual evaporation rate rises over the amount of annual rainfall, and high temperatures lead to an increase in the percentage of evaporation, which makes the benefit from the amount of rain falling very little, and shows the monthly rate of evaporation in the Biskra station during the period 2005-2017 (see the table N°4).

Table 4. Monthly Evaporation Average in mm during the period from 2005-2017 in both Biskra

Month	Sep	Oct	Nov	Des	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Medium
Evaporation	290.2	198.2	144.2	159.8	110.7	140.3	195.5	257.6	329.1	370.6	420.8	385.8	159.8

Source: Biskra Meteorological Stations,2020

It is noted through the table that the highest amount of evaporation recorded was in the summer months, as evaporation begins to rise from May to exceed the amount of evaporation by 300 mm and reach a high of 420.8 mm in July, while the lowest levels during January are recorded at 110.7 mm, and this explains the inverse relationship between evaporation and moisture, the evaporation process negatively affects the water balance, as it causes a lack of moisture in the soil, and thus cracking and scarcity of plants, and the plant is affected by great damage. This requires resorting to technical methods to provide the amount of water necessary for the growth of agricultural crops, the most important of which is watering and fertilizer.

Relative humidity

The monthly relative humidity recorded in the months between March and September is characterized by a decrease in July recorded 29% as a minimum value, while the maximum humidity in December is about 55% (see the table N°5). This means that the air throughout the summer is dry, due to the fact that the area is semi-desert and its distance from water bodies and sea currents, and this affects the quality of plants, their speed of growth and density.

Table 5. Monthly humidity in Biskra2017

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Rate
Humidity%	60	48	37	37	34	32	29	32	44	49	48	55	42

Source: Biskra Meteorological Stations,2020

Winds

The winds are frequent and distributed throughout the year with average monthly speeds of about 4.66m/s, while the maximum speeds are recorded in April and May respectively 6.15 and 5.78m/s. (see the table N°6). During the months June, July, August and September the prevailing winds are south-east or during this period often arrive siroccos (very dry burning wind) with an average of 58 days / year, laying the winter season the winds of the north-east sector are dominant bringing moisture from the north.

Table 6. The average speed of winds in m/s during the period from 1994-2017 in both Biskra

Aug	Jul	Jun	May	Apr	Mar	Feb	Jan	Des	Nov	Oct	Sep	Month
4.07	4.26	4.86	5.78	6.15	4.7	4.55	4.53	4.02	4.5	4.09	4.43	Medium

Source: Biskra Meteorological Stations,2020

Pictures (3, 4). The effect of strong winds on the movement of sand towards roads in addition to sandstorms

Lack and Scarcity of Vegetation

Vegetation as a factor of pedogenesis is directly related to the aridity of the climate of the region characterized by a sparse vegetation composed mainly of halophilic species such as Salsola tetrandra, Atriplex halimus, and some feet of Tamarix africana and Tamarix galica scattered here and the, reflecting the salty character of this plain[5] (see the picture n°01) .

Picture 5. Landscape of the region, (el-outaya)

Human Causes

The human causes of degradation and desertification of the physical environment can be summarized in human interference either in agriculture, industry or services, which do not respect environmental balances, especially in vulnerable regions. In this article, I focused on human interference through agriculture and grazing.

Population Increase

The population of el-outaya area is constantly evolving, as the population reached 5100 people in 1977 to reach 13916 people in 2020, where the number doubled more than two and a half times in 42 years, (see the table N°7), and the growth rate witnessed a decline during the period 1987-1998, reaching 0.46 to rise to 2.47 during the period 2008-2020, Increasing the population is one of the factors affecting the natural environment This is through their exploitation of the field with an increase in the stability factor, as this leads to pressure on natural resources, agricultural land and well water to provide food, as well as vegetation cover through irrational exploitation, which in turn leads to soil salinization and the retreat of the natural environment, and this is what leaves some effects and results that are considered one of the main causes of the phenomenon of desertification.

Table 7. Evolution and growth rates of the population ofel-outaya commune between 1977-2020

Years	Population (Inhabitants)	Growth Rate(%)
1977	5100	4.86 0.46 2.33 2.47
1987	8376	
1998	8811	
2008	11169	
2020	13916	

Source: National Bureau of Statistics + Biskra State Monograph 2021 .

Agricultural and irrigation activity:

In general, it is possible to distinguish two sectors in the study area, the ancient or traditional agricultural sector that distinguishes the oasis of el-outaya and the modern agricultural sector represented in the agricultural rehabilitation, which has been applied in the study area since 1986, and consequently, more water-based fertilizers have been exploited, especially the myopliocin,(see the table N°8). as comes the irrigation water From the manbaa elgoslan dam, which is irrigated in the valley of Al-Hazima, south of the plain, and it has an estimated area of 3050 hectares.

Table 8. Virtues and wells in Al-Wataya Municipality during the period 2002-2019

Years	Water Sources					Number of Well Drilling Licenses For the Private Sector
	Virtues		Wells in the Public Sector			
	Number	Flow(l/s)	Number	Total Depth (mm)	Flow(l/s)	
2002	1	3	10	3161	167	85
2019	1	3	18	3654	245	515

Source: Directorate of Agriculture of the wilaya of Biskra 2021.

Irrigable agricultural areas dedicated to field crops, cereals, fruit tree cultivation, especially palms, and protected agriculture have developed. (see the table N°9.10)

Table 9. Evolution of agricultural area exploited and irrigated for agricultural seasons 2000/2001-2019/2020

Agricultural Season	Total Agricultural Area (Hectares)	Actually Exploited Agricultural Area (Hectares)	Irrigated Area (Hectares)
2000-2001	31062	5281	2846
2001-2002	31060	5386	2927
2012/2013	35525	8183	3838
2013/2014	35525	8183	3920
2014/2015	35525	8187	4098
2015/2016	35502	8187	4146
2016/2017	35419	8198	4183
2017/2018	35407	8198	5327
2018/2019	35312	8198	5344
2019/2020	35525	8198	5438

Source: Directorate of Agriculture of the wilaya of Biskra.2021

Table 10. Evolution of the area of different agricultural species and the quantity of their production 1999/2000 – 2019/2020

Agricultural Season	Grain		Field Farming		Protected Cultivation		Palms	
	Area (hectares)	Production (quintal)	Area (hectares)	Production (quintal)	Area (hectares)	Production (quintal)	Total number of palms	Production (quintal)
1999-2000	843	15315	80	2572	1.48	760	10496	2570
2019-2020	1605	37690	361	87834	36	38254	60292	7255

Source: Directorate of Agricultural Interests Biskra2021.

Picture 6. Exploitation of the agricultural field in modern reclamation areas in the el-outaya area

Despite the development in the volume of production and the area exploited agriculturally, human intervention on the medium was often not rational, and this left several negative effects, including:

- Regression For the oasis of el-outaya, some lands have become producing poor production, others have been neglected due to soil degradation, and as for the palms, most of them have become agedand have not been renovated except in reclamation areas, as the mighty has been planted.
- Do not put windbreaks in the reclamation areas, and this is what left the northwest winds to creep the sand to those areas and thus lead to damage to the crop. Specifically, the southwestern part of the Al-Wataya area is concentrated in the sand dunes, where we find that some of them are fixed by vegetation cover, and others are mobile, when the wind passes through the region, the dunes creep, especially those in the Maghrawa area, where the sand moves to the reclamation areas and negatively affects the agricultural product, and therefore the formation of active sand dunes isone of the dangerous manifestations of desertification [6].
- Salinization of the soil as a result of irrigation through excavations, as evaporation and high temperature lead to the emergence of salt accumulations. (See the photo n° 7)

The salinity of irrigation water exceeds the standard limit of salinity alone, estimated at 3ds / m, this high salinity is attributed to the combined effects of the quality of irrigation water previously salted to very arid climatic conditions producing high evapotranspiration which concentrates the soil solution, and especially to the absence of a drainage network [7]

Picture 7. Salt deposition in agricultural

It has been shown that the abundance of irrigation water weakens the biological capacity of the soil, whether as a result of increased salinization of the soils or increased water logging, and lack of aeration, which exposes them to suffocation to the point of reaching in some cases the point of complete productive sterility, and becoming biologically dead soil[10].

- Plowing the land is a deep plowing, which helps to dismantle and then break up the surface layer of the soil and works to dry the root areas and reduce the effectiveness of the capillary property, and thus reduce the benefit of the rest of the stored moisture and thus the topsoil becomes exposed to volatilization by the wind, especially the northwest winds, and this leads to reducing the depth of the soil and increases the sensitivity of exposure to damage, and thus help to strip it easily, In such circumstances, it is not possible to exploit these soils in agricultural production[8], and the combination of erosion and chemical degradation (soil salinization) seriously affects agricultural resources.[9]

Pastoral Activity

The current exploitation does not take into account the conditions of the natural environment, as the pastures have decreased after the agricultural development, the grazing has intensified and the pastoral load has increased (number of cattle / total surface of the pastures estimated at heads / hectare) (see the table N°11).

Table 11. Evolution of the number of livestock and grazing load in the municipality of el-outaya 1999-2020

Years	Pasture Area (hectares)	Total Number of livestock	Pastoral load (head/ha)
1999	28556	13044	0.45
2020	27102	32672	1.2

Source: Directorate of Agricultural Interests of Biskra 2022

It can be seen from the table that the grazing load is high relative to the prevalent load in semi-arid areas of the world by 1 head to 4 hectares [11] There is pastoral overload, which means loading the pasture with large numbers of animals or certain types of animals that are incompatible with the nature and energy of the pasture, as the pastoral load moved from 0.45 head/ha in 1999 to 1.2 s/ha in 2020. Hence, the pasture is exposed to a large degree of animal pressure, which helps to speed the destruction of vegetation cover and the accompanying severe dredging of the soil, and the weak biological capacity of the environment to regenerate or compensate and continue. Overgrazing and non-enforcing of grazing laws are among the reasons that have led to the decline of pastures as well as the development of plants not consumed by livestock such as Peganum harmela.


Pictures (8, 9). Illustrate the decline of pastures resulting from overgrazing in the area.

Finally, it can be said that the long-term consequences and effects of desertification cause the disappearance of life in the affected areas, while in the short term they require mobilization of the situation, and here it is not easy or easy work to maintain the fragile balance between the effects of changes caused by desertification and the necessities or requirements of local units and agglomerations [12].

Preventive Treatment Measures to Combat Desertification in the Study Area

Intensive land-use patterns have had negative impacts on vegetation and arable land, so the following measures have been taken

Preparation of Pastures and Rehabilitation of Vegetation Cover

This preparation allows the improvement of pastures through the redevelopment of vegetation cover, which is represented in:

Successive defense operation by placing observation teams.

PLANTING FORAGE TREES AND SHRUBS SUCH AS TRIBLAX, PROSPIS

Rational use of pastures by rotating and reducing the pressure of the pastoral load by providing feed.

Integration Between Irrigated Oceans and Intensive Pastures

Several experiments have shown that the cultivation of irrigated fodder provides a better yield on the one hand and reduces the pressure of livestock on pastures on the other hand.

Enactment of a Practical Pastoral Law

The effective application of deterrent and harsh pastoral laws against violators and pastoralists who practice pastoralism illegally.

Attention to the Distribution of Drinking Points forAnimals

It is necessary to pay attention to the good distribution of drinking water points for animals so that it suits nature, the condition of pastures, the type of animals prevailing in pastures and the possibilities available to shepherds.

Preserving the Soil from Increasing Salinization

One of the priorities of this province is to reduce watering the soil with salt water or dispense with it completely, but we can find solutions to this water so as not to let it go away like this, by placing a filter station where the latter converts salt water into water suitable for irrigation, or treated by mixing it with fresh water from another water source (deer source dam), for example, and so it is used without losing it, in addition to this attention should be paid to choosing a system The irrigation network that suits the natural conditions of the area must be covered if possible, and if it is not possible to cover it, trees can be planted along the streams of the water channels to reduce the amounts of water evaporated from the canals, in addition to preserving the soil from the dangers of wind erosion and evaporation of soil moisture.

Land Washing

It is one of the methods used to remove even a small part of the salts, where washing is done by immersing water in those areas for a short period and then discharging this water through those channels and it can be noted that this process takes place at the end of the summer when the lands are at rest and this is because the concentration of salts on the surface of the lands in this period is very large.

Placement of Windbreakers

Salt-resistant trees and shrubs should be used, as they protect the area from the wind and on the other hand preventevaporation, and from the types of trees and shrubs that are suitable for windbreakers and as a barrier to protection:

Eleaganus-Angustifolia,Gleditsia-Triacanthos,Maclura-Curantiaca,Tamarix Pontandra. Eucalyptus accidenta lis

Stop the Encroachment of Sand

Since the movement of winds and sand dunes of the factors that help to expand the circle of desertification and increase its intensity, it is necessary to work to stop the movement of these sands and try to install them and there are many ways to install sand dunes.

- Popularization of the use of palm fronds between 2.6 and 2.8 meters in length, in order to avoid the occurrence of sand whirlwinds that occur in spring and summer.

Pictures (10, 11). Fixationwith palm fronds in el-outaya

- Installation using stone barriers, and this method is used in areas where there are many and increasing wind speed and strength, as a barrier of basalt and calast stones is formed to avoid the strength of granule transport.

Picture 12. Fixation using stones

- Biological stabilization is by using various plants adapted to drought and sand such as: Figuier Ordinaire, Figuier, Olivier de chine,Vigne

Awareness Raising and Sensitisation

Since the human being is a major factor causing the phenomenon of desertification, it is necessary to develop awareness programs for the community and raise awareness of the seriousness of the phenomenon and its negative repercussions on it in order to contribute to mitigating its severity and preserving its pastoral and agricultural field for the goal of sustainability.

CONCLUSION

The study area of the municipality of el-outayais a transitional area between the Saharan Atlas and the Sahara, located within the semi-arid climate region that is characterized by several characteristics: high temperature, fluctuating rain, low humidity and high evaporation, and strong winds, which effectively contributed to changing the environmental and biological systems of the region and rehabilitating it to be one of the areas very affected by the phenomenon of desertification.

In addition to the natural factors represented primarily in climatic conditions, we find that the human factor also comes at the forefront of the causes leading to the phenomenon, the irrational human intervention represented mainly in: agricultural activity, overgrazing, poor management of pastures, an increase in the percentage of pasture regression, in addition to irrigation techniques leading to water logging and salinization of the soil and the use of modern agricultural methods that are not in line with the nature of the region, in addition to the growing increase in the population and their shift towards agglomeration. It leads to expansion at the expense of agricultural land.

All these reasons, both natural and human, have led to several repercussions on the medium: wind and water erosion, sand encroachment, soil salinity, and degradation of vegetation cover.

However, despite all these manifestations that negatively affected the medium, we did not observe the necessary measures, whether at the individual or collective level, which led to an increase in the severity of the phenomenon, and therefore if these abuses are not met with the necessary confrontation and confrontation, the phenomenon will affect its effects for several generations.

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Citation: **Dr. Bouchama lydia.** *The Phenomenon of Desertification: Causes, Consequences and Control Solutions: The Case of the El-Outaya Area in Bikra (Algeria). Int J Innov Stud Sociol Humanities 2023;8(1): 326-337. DOI: https://doi.org/10.20431/2456-4931.080134.*