

Climate Change in Peru. Implications for Environmental Policies

Bessy Castillo-SantaMaría¹, JoséRuiz-Nizama², Manuel Manrique-Nugent³, CarlosPozo-Curo³, Danny Villegas Rivas^{4*}, Ricardo Ruiz Villavicencio¹, José Palacios Sánchez¹, Margot Rodríguez Mayhuasca⁵

¹ Postgraduate School. Universidad César Vallejo. Perú.

² Universidad Nacional del Callao. Peru.

³ Universidad Nacional Autónoma de Huanta.Peru.

⁴. Faculty of Civil Engineering. Universidad Nacional de Jaén. Cajamarca, Peru.

⁵. Universidad Nacional Tecnológica de Lima Sur. Peru.

*Corresponding autor: danny_villegas1@yahoo.com

Abstract

The effects of climate change that are being generated worldwide, the governments of the world are concerned and committed, through the development of environmental policies to reduce and / or mitigate harmful natural disasters in the society and economy of the peoples. Therefore, the Peruvian government raises the need to reduce pollution from the main productive activities, through the implementation of standards that allow regulation and regulation. In this context, the research aims to evaluate the effectiveness of environmental policies against climate change in Peru. Study in which the socio-critical paradigm was used, a mixed approach and in the collection of quantitative data, government information from the period 1993 - 2018 was used; and the qualitative approach, a documentary review and interview was carried out, proceeding to the descriptive statistical analysis for the interpretation of data, as well as the structured and documentary interview. Where it was concluded that, in Peru, environmental policies have not been efficient to counteract the effects of climate change; Due to government mismanagement at all levels, which allows extending new strategies until 2030.

Keywords: climate change, environmental policies, temperature, precipitation and relative humidity.

INTRODUCTION

The environmental system in the world is altered by anthropic and natural circumstances, the effect of these variations in climate change, natural disasters occur that affect the most vulnerable populations. The Earth's climate changes over time and during the last 650,000 years there have been cycles of deglaciation, which are altered through the solar energy that the planet receives (NASA, 2020). Given these facts, Peru is no stranger to such circumstances, the various natural phenomena that occur are due to the misuse of natural systems. And for 55 years the glaciers decreased to 61%, losing 11.5 square kilometers (TRT, 2020). Coinciding with research carried out by competent institutions that affirm that the impact of global warming has been reducing the Andean glaciers of the Cordillera Blanca of Peru (Chimira, et al., 2018). This to the detriment of the different localities settled in the nearby valleys due to the increase of water in the rivers and the overflows produce floods and disasters in the local, regional and national economy. Given these facts, the government, through policies, is committed to reducing greenhouse gas emissions in the different sectors to 30% by 2030 (Andina, 2020). In such a circumstance, the competent authorities undertake to enforce the laws by reducing 67% in

forestry, 12% in energy, 6% in industries, 5% in agriculture, 4% in waste and 2% mitigation, sectors that generally high levels of contamination to date due to lack of monitoring and supervision (Minam, 2016).

Thus, the development of the research shows the existence of a control based on environmental management, where the authorities lack vigilance in places where there is frequent use of the extraction of natural resources, change of land use, applications of agricultural pesticides in farm fields, industries. That are not verifiable by the competent authority. The sum of this means that the increase in temperature, precipitation, humidity, atmosphere pressure, sunlight, ultraviolet radiation have varied, resulting in global warming and the incidence of diseases. However, environmental policies are at the service of authorities, companies and the community in general, but there is little interest in developing practical applications for reforestation, tree planting. The management carried out by the competent authorities is part of a slow action and a weak management in the achievement of environmental sustainability. For what we propose, how does climate change affect Peru? Whose objective is to evaluate the temperature, precipitation and relative humidity in the Peruvian territory.

ENVIRONMENTAL POLICIES

Environmental policies in the world, organizations and governments have not been able to contain the advance of the depredation of ecosystems, generating adverse and harmful environmental phenomena for humanity, especially in vulnerable and rural areas far from political activity. Where the United Nations (UN) declares that climate change affects all the countries that make up the continent, which produces great adverse and negative impacts on the economy, on people and communities, for which it is proposed to comply with sustainability the development goal, number 13, climate action, referring to: (a) strengthen resilience to face the climate and natural disasters, (b) implement measures to face climate change through policies, © developed countries should fulfill the commitment to manage economic resources for the good of developing countries with vulnerability

Consequently, this is reflected in the fact that in each of the countries there are balanced and adequate environment for the full development of life, as well as the changes in high and low temperatures, floods, droughts, hail, and huaycos, giving birth to new species in different habitats due to migratory effects. However, environmental governance in Peru begins its timely activities in the closest areas, under the influence of communities, but outside distant places, difficult to control, whose effect is risk to human life by defending their territory, their Habitat and Biodiversity. Meanwhile, the Ministry of the Environment (Minam, 2005) in the environmental law bases the objective of: Establishing basic principles and standards that ensure the effective exercise of the right to a healthy, balanced and adequate environment for the full development of life, as well as compliance with the duty to contribute to effective environmental management and to protect the environment, as well as its components, with the aim of improving the quality of life of the population and achieving the sustainable development of the country (pp. 22, 23).

Therefore, the Peruvian government implemented Supreme Decree No. 009-2009-Minam, in order to protect the environment. And, the Presidency of the Republic (2009) emphasizes that public and private institutions that provide services to the State must implement eco-efficiency to

produce more with fewer resources that generate low environmental impacts. In the same way, the community is also called to raise awareness about the environment through "the rights, obligations, powers and responsibilities of society as a whole ... (p.1)" Law of the Presidency of the Republic (2016).

As noted (Minam, 2003) considers causes that affect climate change, all those activities such as: (i) production and consumption of fossil fuels, (ii) agricultural production, (iii) change in land use, (iv) industrial processes and (v) management of organic and liquid waste, for which it seeks to minimize, through the implementation of policies, plans, programs at the sector and regional level, in order to mitigate the negative impacts of climate change.

Effects of climate changes

The magnitude of climate change in the South American region, and especially in Peru, is reflected in the de-glacialization of snow-capped mountains, due to the increased deforestation of forests, excessive increase in solid waste and the lack of environmental education. That are aggravated by problems that affect the population. In this sense, Lauren, et al. (2020) identify that climate change produces effects that alter various dangerous properties for populations, which has increased vulnerability ... Consequently, ecosystems are altered by the weakness of the inappropriate use of natural resources and the lack of sustainability effect of a culture and habits on people, this is where governance must prioritize the targeting of limits by regulation laws, which communities and government must comply with.

Consequently, in Peru, the territory with the largest natural reserve is in the jungle region, so there is an urgent need to generate evaluation and monitoring patterns for the protection of flora and fauna in a state of extinction, due to the effect of high temperatures and indiscriminate felling of forests, which cause loss of biodiversity, destruction of towns under the influence of rising rivers. (Caballero et al., 2018) argue that deforestation in 2017 and 2011 was 10% and 53% respectively due to the effect of illegal mining. To this is added, the construction of the Interoceanic Highway with a deforestation of 425% between the years 2006 with 2010 hectares per year and 2011, with 8536 hectares per year (Romo, 2018). Consequently, the pollution caused by the mercury effect of mining tailings affects the rivers of the Amazon, producing a decrease in aquatic fauna, which generates risks in the consumption of food. To this is added the ecological vulnerability, erosion of degraded and contaminated soils.

In the Sierra region in general, the varied temperatures affect crops and animal fields, generating losses in economic activity that leads to the generation of Andean rural poverty, where the various programs and projects do not achieve sustainability, preventing communities do not achieve their quality of life and well-being.

And in the coastal region, the fundamental factor attributed to climate change is the indiscriminate use of pesticides due to the presence of new pests in agriculture that become resistant to chemical applications. Other factors such as change of land use from agricultural to urban without planning, tailings mining on the central highway near rural areas. In this sense, Castillo, et al. (2020) report that air pollution is the product of agricultural pesticides, which negatively affect the environment, contributing to the generation of a poor state of life for people. Residing in rural areas and close to farmlands.

Climate change by 2030 will have temperature variations with respect to the coast, mountains and jungle of Peru.

Consequently, these variations will affect ecosystems, (Soroye, et al., 2020) argue that temperatures will fluctuate in increasing and decreasing ways and species are at risk of decreasing, also being influenced by the change in land use that causes a decrease in the range of species. However, (Sánchez, *et al.*, 2020) refers that the accumulation of greenhouse gases is altering climate change, which affects agricultural and livestock activities and shows that each region has a different vulnerability. What, (Bulege-Gutiérrez & Custodio, 2020) reveal that in the years 1986 to 2016 in Peru, there was a retreat of the glacial mass of the Cordillera Huaytapallana, with an increase in the minimum temperature. Various factors that affect the climate of our region.

However, precipitation and relative humidity, occur through evaporation and global warming, generates the dissolution of the current cloud masses. Where, the National Meteorology and Hydrology Service (SENAMHI) reports that the precipitation on the coast is extremely dry, it generally does not rain, but is characteristic of the dense fogs and small drizzles that occur in the months of May and November. The effect of this is the cold, with temperatures that oscillate annually between 14 and 18 °C, decreasing humidity in summer. Therefore, in the highlands and the jungle, the dry seasons appear in May and October with the highest solar radiation, with rains in December and March that are classified as winter, with temperatures ranging between 9 - 18 ° C in the highlands, and tropical climate present. In the jungle at 26-40 °C. (Subharthi & Rajib, 2020) argue that the probable maximum precipitation is a consequence of climate change. (Yu, et al., 2020) indicate that different changes in precipitation and temperature affect the bacterial and fungal community of the soil.

Environmental changes caused by climate change must be taken into account as a priority to manage mitigation measures and avoid damage to the integrity of people. For what is important, they consider that there is instability in the environmental system generated by people and harmful to nature (Senenko, et al., 2019). Conserving natural resources does not mean having economic resources, but having educational resources. Given this, it is specified that it is not only an environmental concern, the political space is also important and necessary (Lorenzo & Bueno, 2019). That is why it is important to highlight the various resources that are included, water resource is also being affected by the actions of society and leads to proposing environmental strategies that mitigate its advance. Being important for the protection of biodiversity resources, the restoration and protection of habitats (Callum, et al., 2020).

METHODOLOGY

The current of thought, for the present research work, corresponded to the constructivist or critical partner, because it was the researcher who becomes a collective subject of self-reflection that is not only immersed in the investigated object, but is a constitutive part of it (Hernández, et al., 2014). Regarding the approach, it is mixed and the study design is a simple evaluative case, since it was intended to explain, in detail, if the public policies implemented in Peru are designed to eliminate or mitigate the effects that climate change could have (Simons, 2011).

The quantitative data, for its analysis, were obtained from the National Institute of Statistics and Informatics (INEI, 2019) for the period 1993 - 2018 from the regions of the coast, mountains and jungle. Through statistics it was analyzed and determined whether climate change, which is occurring in the world and in Peru, has effects on environmental temperature ($^{\circ}\text{C}$), rainfall (mm) and relative humidity (mm).

For the qualitative approach, various sources of written information were used, where they account for the effects of climate change that are taking place in Peru and the world and the effectiveness of public policies in Peru to face climate change. For the interview, 12 people involved with the environmental issue were used.

RESULTS AND DISCUSSION

A. Quantitative results

1. Result of the temperature measurement ($^{\circ}\text{C}$), in the natural regions of the coast, mountains and jungle of Peru, 1993 - 2018, as shown in Table 1.

In Table 1 and Figure 1 it is observed that the environmental temperatures in the coast, sierra and jungle have maintained an average temperature of 21.5731°C (coast), 12.4962°C (sierra) and 24.5038°C (jungle) in the period 1993 - 2018, which would not explain important temperature variations due to the effect of climate change in Peru. In 1997 there is an unusual increase in temperature (24.2°C) that could be due to global warming that occurred in the world.

Table 1: Temperature in natural regions of Peru.

	Temperature $^{\circ}\text{C}$ Coast	Temperature $^{\circ}\text{C}$ Sierra	Rain Forest $^{\circ}\text{C}$
Valid	26	26	26
Lost	0	0	0
Half	21.5731	12.4962	24,5038
Dev. Deviation	, 92976	, 68555	1.67200
Rank	4.10	3.30	4.10
Minimum	20.10	10.50	22.70
Maximum	24.20	13.80	26.80

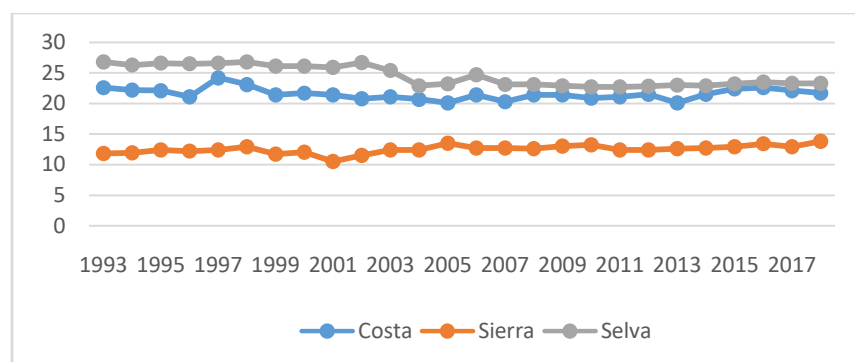


Figure 1: Temperature variation in the natural regions of Peru 1993 – 2018

B. Result of the precipitation measurement (mm), in the natural regions of the coast, mountains and jungle of Peru, 1993 - 2018, as indicated in Table 2.

Table 2 and Figure 2 show that the precipitations (mm) that have occurred on the coast and mountains have been almost uniform since 1999, with averages of 88.10 mm (coast), 709,800 mm (mountains) in the period 1993-2018. In the jungle region, precipitation has had a very irregular behavior with an average of 1,731,500 mm and standard deviation and variance with values that indicate this behavior. It can be seen that in 1997 and 1998 there is an increase in rainfall in the three natural regions, which could be attributed to global warming, as in many parts of the world.

Tabla 2: Statistical data on precipitation (mm).

		Coast precipitation (mm)	Sierra precipitation (mm)	Rainforest precipitation (mm)
N	Valid	26	26	26
	Lost	0	0	0
Half		88,1000	709,0000	1,825.7192
Dev. Deviat		131.81714	89.83335	421,45880
Variance		17375,758	8070,031	177627,516
Rank		674.00	282.20	1,579.90
Minimum		22.30	568.10	1,156.00
Maximum		696.30	850.30	2,735.90

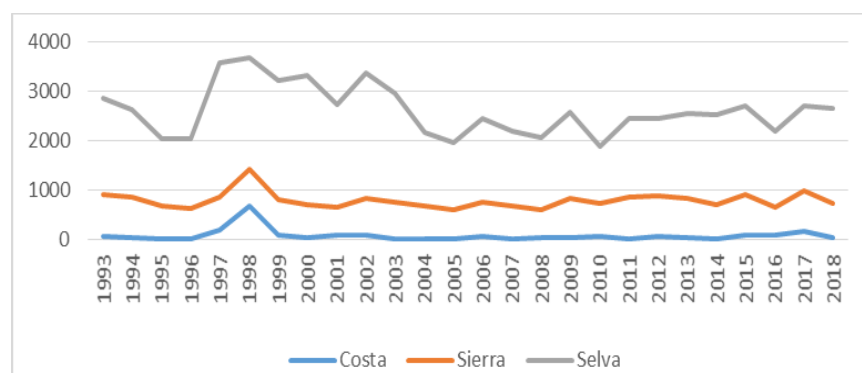


Figure 2: Precipitation variation in the natural regions of Peru 1993 – 2018

3. Relative humidity measurement result (%)

In the natural regions of the coast, mountains and jungle of Peru, 1993 - 2018, as observed in Table 3.

Table 3 and Figure 3 show a uniform behavior of relative humidity in the natural regions of Peru in the study period, with averages of 79.0885% on the coast, 64.6923% in the highlands and 85.2769% in the jungle. The variability statistics are in the acceptable ranges. It could be inferred that climate change affects humidity in the natural regions of Peru.

Table 3: Statistical data of relative humidity (%).

		Relative humidity (%) Coast	Relative humidity (%) Sierra	Relative humidity (%) Forest
N	Valid	26	26	26
	Lost	0	0	0
Half		79.0885	64.6923	85.2769
Dev. Deviation		1,61055	8.16886	4.86426
Variance		2,594	66,730	23,661
Rank		6.00	22.30	14.70
Minimum		76.40	50.80	79.00
Maximum		82.40	73.10	93.70

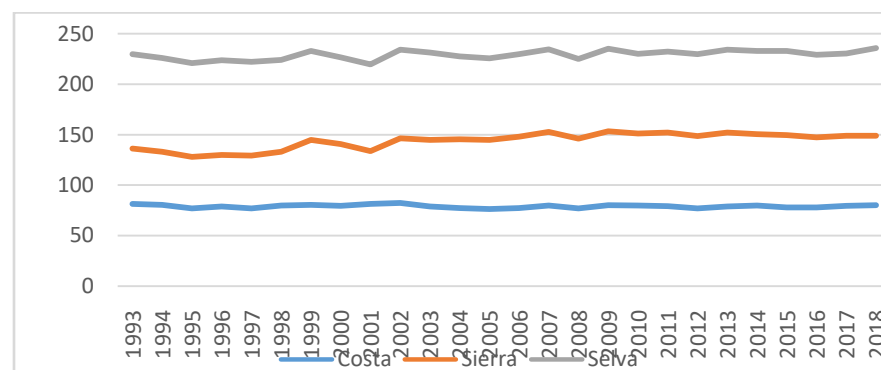


Figure 3: Variation of relative humidity (%) in the natural regions of Peru, 1993 - 2018

B) Results for qualitative analysis

From the analysis of the information and interviews carried out on the effects of climate change that is originating in Peru, the following findings have been obtained:

b.1) Peru has suffered the loss of more than 22% of the glacial areas. The Pastoruri case is the most emblematic. 30 years ago it was an important tourist place, today it looks like a hill with rough surfaces.

b.2) The fauna and flora of the Peruvian jungle region is in danger of extinction, due to the effect of illegal mining, indiscriminate logging and contamination of rivers by mercury mining tailings.

b.3) The loss of crops vulnerable to climate change.

b.4) Frequent and torrential rains "never seen before" that have caused the increase in the flow of the rivers to produce overflows, with the consequent destruction of the road infrastructure. As was the case in Piura in the coastal region in 2019.

b.5) The common causes, which the interviewees reached, that have caused climate change in Peru, the interviews, were the following: 1) Environmental pollution, caused by man and inefficient management by the authorities 3) Deforestation uncontrolled, especially in the jungle area, 4) Informal mining, especially in remote areas, population centers, in the mountains and jungle, 5) Little effectiveness of public policies, 6) Weak control by the State.

CONCLUSIONS

The effects of climate change that is taking place in Peru cannot be mitigated or controlled through inefficient public policies. Consequently, it can be deduced that climate change will continue to increase due to the effect of population growth, illegal mining, logging of forests, contamination of the soil, rivers and the lack of awareness in humanity, given these facts the government is proposing new strategies to by 2030.

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CONFLICT OF INTERESTS

The authors maintain that they have no conflict of interest and declare that the research is carried out with their own resources.

REFERENCES

1. Andean. (May 19, 2020). Paris Agreement: Peru's commitments to climate change. Obtained from <https://andina.pe/agencia/noticia-acuerdo-paris-los-compromisos-peru-frente-al-cambio-climatico-669371.aspx>
2. Bulege-Gutiérrez, W. and Custodio, M. (2020). Climate change and glacier retreat in the Cordillera del Mountrain Huaytapallana, Peru. Water Technology and Sciences, 11 (2). doi: <https://doi.org/10.24850/j-tyca-2020-02-06>
3. Caballero E, J., Messinger, M., Román-Dañobeytia, F., Ascorra, C., Fernandez E, L., & Silman, M. (2018). Deforestation and forest degradation due to gold mining in the

- Peruvian Amazon: a 34-year perspective. Remote sensing, 10 (12): 1-17. Retrieved from <https://www.mdpi.com/2072-4292/10/12/1903/htm>
4. Callum M, R., O'Leary, B. and Hawkins, JP (2020). Both climate change mitigation and nature conservation require higher protected area goals. The publishing house of the royal society. doi: <https://doi.org/10.1098/rstb.2019.0121>
5. Castillo SM, B., Ruiz T, JO, Manrique N, MA and Pozo, C. (2020). Contamination by agricultural pesticides in the fields of crops of Cañete. Espacios, 41 (10): 1- 12. Obtained from <http://www.revistaespacios.com/a20v41n10/20411011.html>
6. Chimira N, A., Carolyn H, E., Harrinson, J. and Narro-Pérez, R. (2018). Sedimentological analysis of the Jircacocha paleolac, Valle Cojup Cordillera Blanca, Peru. 9 (26). Retrieved from <https://doi.org/10.36580/rgem.i5.9-26>
7. Hernández Sampieri, R., Fernández Collado, C. and Baptista Lucio, M. d. (2014). Cientific investigation methodology. Mc Graw Hill.
8. National Institute of Statistics and Informatics. (2019). Peru Yearbook of Environmental Statistics. INEI.
9. Lauren T, S., Gater, DR, Espinel, Z., Kossin, JP, Galea, S. and Schultz, JM (2020). Prepare people with spinal cord injury for extreme storms in the age of climate change. EClinica Medicine, 18 (100232): 1-3. doi: <https://doi.org/10.1016/j.eclim.2019.12.002>
10. Lavorel, S., Locatelli, B., Colloff, MJ and Bruley, E. (2020). Co-producing ecosystem services adapt to climate change. The Royal Society Publishing, 375 (1794). doi: <https://doi.org/10.6084/m9.figshare.c.4782609>.
11. Lorenzo, C. and Bueno, M. d. (2019). Conservation of nature in North-South relations: payment for ecosystem services. Journal of Social Studies, 40-50. doi: <https://doi.org/10.7440/res71.2020.04>
12. Minam. (24 of 10 of 2003). National climate change strategy. Supreme Decree No. 086-2003-PCM. A Peruvian man. Retrieved from https://www.oefa.gob.pe/?wpfb_dl=3655
13. Minam. (2005). General Law of the Environment. Law No. 28611. Minam. Obtained from <http://www.minam.gob.pe/wp-content/uploads/2017/04/Ley-N%C2%B0-28611.pdf>
14. Minam. (2009). Climatic scenarios in Peru for the year 2030. SENAMHI. Obtained from <http://repositorio.senamhi.gob.pe/bitstream/handle/20.500.12542/141/45469476-Escenarios-climaticos.pdf?sequence=1&isAllowed=y>
15. Minam. (2016). Peru 2030. The vision of Peru we want. Obtained from http://www.minam.gob.pe/wp-content/uploads/2016/07/Peru-2030_la-visi%C3%B3n-del-Per%C3%BA-que-queremos.pdf
16. NASA. (May 19, 2020). Climate change: How do we know what we know? Retrieved from https://climate.nasa.gov/earth-now/#/spacecraft?spacecraft=sc_aqua&vitalsign=satellites
17. ONU. (sf). Objective13: Adopt urgent measures to combat climate change and its effects. Retrieved from <https://onu.org.pe/ods-13/>
18. Presidency of the Republic. (May 14, 2009). Eco-efficiency measures for the public sector. Supreme Decree No. 009-2009-Minam. A Peruvian man. Obtained from http://www.minam.gob.pe/wp-content/uploads/2013/09/ds_009-2009-minam.pdf
19. Presidency of the Republic of Peru. (23 of 12 of 2016). Law of Integral Management of Solid Waste. Legislative Decree No. 1278. El Peruano. Obtained from <https://sinia.minam.gob.pe/normas/ley-gestion-integral-residuos-solidos>

20. Romo, V. (September 5, 2018). Deforestation by gold mining in Mare de Dios is the highest in the last 32 years. Retrieved from <https://es.mongabay.com/2018/09/peru-deforestacion-mineria-madre-de-dios/>
21. Sánchez Mendoza, B., Flores Villalva, S., Rodríguez Hernández, E., Anaya Escalera, AM and Contreras Contreras, EA (2020). Causes and consequences of climate change in livestock production and animal health. Review. Mexican Journal of Livestock Sciences, 126-145. doi: <https://doi.org/10.1016/j.pt.2016.04.015>
22. Senenko, N., Chechel, A. and Kirsanova, V. (2019). Characteristic and benefits of the ecological status of the soil and groundwater of the newly created teaching methodology. International Journal of Recent Engineering and Technology, 8 (4): 1-10. doi: 10.35940 / ijrte.D1011.1184S19
23. Simons, H. (2011). The case study: Theory and practice. SL Morata. pp. 1-264
24. Somerville, P. (2020). A critique of the climate mitigation policy. Politics and Politics, 48 (2): 355-378. doi: <https://doi.org/10.1332/030557319X15661682426163>
25. Soroye, P., Newbold, T. and Kerr, J. (2020). Climate change contributes to the widespread decline of bumblebees on all continents. Science, 367 (6478): 658-688. doi: 10.1126 / science.aax8591
26. Subharthi, S. and Rajib, M. (2020). Increased Maximum Allowable Precipitation in a Changing Climate in India. Journal of Hydrology, 585 (124806). doi: <https://doi.org/10.1016/j.jhydrol.2020.124806>
27. TRT. (June 8, 2020). Climate change is melting the glaciers of Peru. Obtained from <https://www.trt.net.tr/espanol/ciencia-y-tecnologia/2017/07/18/el-cambio-climatico-derrite-los-glaciares-de-peru-773081>
28. Yan-Hong, G., Dong-Min, Z., Wen-Bin, K., Chao, F., Yiu-Ying, P., Guo-Jun, S. and Jian-Sheng, Y. (2020). Inherited effects of the amount and frequency of precipitation on the aboveground plant biomass of a semi-arid grassland. Science of The Total Environment, 705. doi: <https://doi.org/10.1016/j.scitotenv.2019.135899>
29. Yu, S., Kaoping, Z., Qian, L., Jin_Sheng, H. and Haiyan, C. (2020). Interannual climatic variability and altered precipitation influence the structure of the soil microbial community in a grassland on the Tibetan plateau. Total Environmental Science, 714 (136794). doi: <https://doi.org/10.1016/j.scitotenv.2020.136794>