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Review Article

Effect of an Atypical Rainy Season on the Population of Bilbao

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Abstract

Climate change is causing atypical weather situations that have an effect on the population. Between November and December 2021, there was abundant precipitation corresponding to 70 % of the average cumulative value of a semester. These episodes have effects on the population and in this study the effects due to them are analyzed and future actions are proposed to be able to face new similar events.

Introduction

Bilbao is a city located on the northern coast of the Iberian Peninsula, as shown in (Figure 1) close to the Cantabrian Sea (15 km from the coast). It located in the Atlantic or Oceanic climatic zone [1] which is characterized by mild winters and not very hot summers. Precipitation, as in the rest of the coastal area, is constant and exceeds 1000 l/m^2 per year.

In order to know the exact precipitation data, a meteorological station was installed on the roof of the Bilbao School of Engineering (EIB/BIE) in 2000 [2, 3] and the values recorded by this station are contrasted with those recorded by the Zorrotza station [4] that is the nearest in the network of meteorological stations of the Basque Government, Euskalmet [5] 3 km away from the former (Table 1).

The case study was the rainy period November-December 2021, which was atypical. It began to rain on November 21 and was raining continuously for 21 days, with an accumulated value of 427.90 l/m^2, as shown in (Figure 2).

Table 1: Recorded data for Precipitation [3].

Year	Annual accumulated precipitation (l/m^2)	Year	Annual accumulated precipitation (l/m^2)
2000	1011	2012	975
2001	863	2013	1305
2002	1030	2014	864

2003	1141	2015	1092
2004	1072	2016	1115
2005	1209	2017	1128
2006	978	2018	986
2007	1089	2019	978
2008	1346	2020	929
2009	1039	2021	1104
2010	1155	2022	648

Figure 1. Location of Bilbao [2].

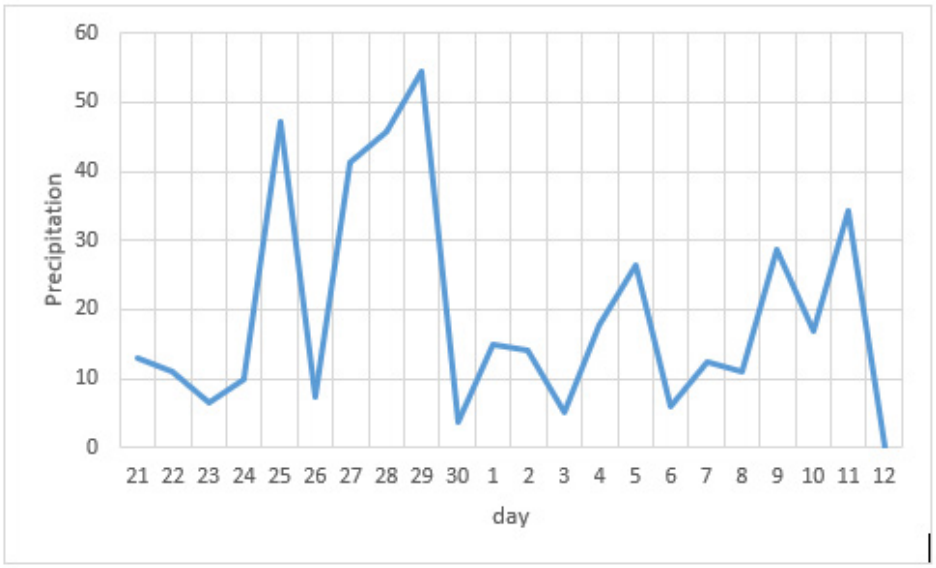

Figure 2: Daily precipitation.

Climate change is not being reflected in the same way in all parts of the world. As the United Nations states in its 2024 report [6] in some areas the effects are increases in temperature, while in others, precipitation is more abundant or more torrential; that is, the precipitation pattern of many regions has changed. The effect of climate change affects the population and specifically, in this rainy period it led to effects that are going to be analyzed, to try to minimize the influence of events in the future.

Case Study

This atypical situation of prolonged intense precipitation over time that can be considered within the effects of Climate Change as "Effects of Climate Data", and it must be analyzed taking into account, for this phenomenon, the following data:

- Accumulated precipitation (monthly),

- Number of consecutive precipitation days.

In 2021, 230.90 l/m^2 were recorded in November and 197 l/m^2 in December. In fact, in the news published in a local newspaper, the headline was "Euskalmet describes the rains recorded in the Basque Country during the last 21 days as extraordinary" [7-9]. In just under 25 days, the Basque Country had registered the record for accumulated precipitation on consecutive days in the last 100 years. In particular, during a semester in the Greater Bilbao area it usually rains about 600 l/m^2 and in just over 20 days just over 70% of the total amount fell.

Analysis of the Effects on The Population

From the signs or atypical phenomena due to climate change, they can produce direct and indirect effects that will cause determinants and social dynamics and will lead to impacts on health. Figure 3 [10] shows the icons illustrating the possible effects.

In the case study, it can be considered that the direct effect was "Floods". And the most pronounced indirect effects, due to them, are the following:

- Declining in agricultural and livestock productivity

- Changes in land use

- Decline in physical work capacity and labour productivity

- Decrease in water quality

As a result of both effects (direct and indirect), the determinants and social dynamics that have been mostly conditioned are:

- Increasing health and socioeconomic inequalities

- Increased vulnerability by age, gender

- Increase in the health program and damage to health infrastructures.

All this can have the following impacts on health:

- Increased injuries and trauma

- Decrease in Mental Health and increase in mental illnesses and suicides (Figure 3).

Considering the location and the chosen effect, the junctions between the circles have been traced at different levels in figure 3. These describe a successive chain of relationships between them (from direct to indirect effects, to determinants...), starting from the previously selected signal to all the relevant health impacts (bottom row) in the chosen location and all this is shown in (Figure 4).

Figure 3: Outline of effects and impacts [10].

Figure 4: Relationship between effects and impacts in the selected health area [10]

In this case study, there were numerous publications of the impacts due to it and in the following news [11-14], the impacts that the chosen event had on health in the chosen area are briefly described.

-Amplias zonas de Bizkaia y Gipuzkoa afectadas por unas inundaciones que dejan 400 incidencias (eldiario.es)

-Inundaciones en Bizkaia: Coches sumergidos e inundaciones por la lluvia en Bizkaia, que ya evalúa daños | Actualidad | Cadena SER

-Inundaciones en Bizkaia: El temporal deja 200 litros por metro cuadrado y satura el Cadagua y el Nervión | El Correo

-Noviembre más lluvioso del siglo XXI en el noroeste de Euskadi (europapress.es)

In addition to all the material losses (plants, flooded garages, stopped trains, leaks in houses, etc.) all the indirect effects must also be considered, since when it rained it was difficult not to get wet when commuting to work, studies, etc., which implied health problems for many citizens and animals. The crops and the slopes of the mountains were in an unstable situation with the possibility of landslides. In addition, the prolongation of the rain episode made citizens feel vulnerable, discouraged, wet, and although suicides should not be publicized in the press, at the local level, it became known that they had increased. This phenomenon not only "stresses" people, even worse if possible, for the vulnerable population since they will not have for who reach a point where they no longer have clothes or shoes to wear and do not know where to take shelter when going for a walk or trying to carry out leisure activities (sports, hiking, etc.), but also affects livestock and agriculture (with animals with colds and fields flooded with so much accumulated water). The populations most vulnerable to these episodes are the elderly and children, but the whole society was exposed to this situation. Nor should we forget animals, whether they are companion or livestock, as well as agriculture, fields, mountains, and so on. It is a very critical situation for everyone.

Proposed Measures for Future Situations

The measures that could be taken in the locality to improve adaptation to climate change in the chosen locality would be the following:

- To prevent flooding in the streets, Storm Tanks are being built.

- Canopies are being installed in the parks, so that, even if it rains, people can go out for a walk without getting wet.

- Provide psychological support to the population and plan activities "undercover"

- Raise awareness among the population that these situations can occur more frequently so that they are able to assume them

- Improve the health system to deal with trauma and mental health

Conclusion

It could be concluded that floods produce many indirect effects and ultimately end up affecting mental health in a very significant way, even increasing the number of suicides. Also, important but not so critical are numerous injuries due to the high number of accidents that occur. Future precipitation could increase the risk associated with this direct effect in a severely, due to massive precipitation resulting rom climate change. And whatever happened in November-December 2021 could be repeated in any time due to seasonal instability.

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Conflict of Interest

None.

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