Sustainable housing and the quality of life of the inhabitants in the Glaciers area - Huaraz Peru 2022

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Abstract

The objective of this research is to propose a bioclimatic housing design that allows the comfort of users in glacier areas, due to the extreme climates of the area, the inadequate existing construction systems and the waste of solar radiation, which significantly affect the health of the inhabitants. The methodology applied for the proposal was based on bioclimatic criteria (thermal, acoustic and light comfort) from the climatic analysis of the area using the bioclimatic chart (Olgyay, Givoni-Milne) and Mahoney's Table, using digital tools (Ecotech, climate consultant). As a result it was achieved that through the use of local materials the thermal comfort of the proposed adobe walls has the characteristic of being able to insulate the cold with a thermal resistance of 0.25 W/m C, the greenhouses present help to control the temperature of the house, for lighting clean technology was incorporated into the design, as the 4-slope roofs are beneficial in the context of the rains that occur in the place. In conclusion. The strategies applied significantly improve the quality of life of the inhabitants, complementing their environment and can be replicated in areas with the same climatic characteristics.

Keywords: Quality of life, Glaciers, Construction system, Thermal comfort, Bioclimatic strategies.

I. INTRODUCTION

The concept of quality of life it can be generally take aspects of social welfare which can be measured through the development of equipment and infrastructure (1), In the architecture context covers a wider spectrum because this covers different aspects which a house must take in order to generate comfort for those who inhabit the place. At this point quality of life can be decribe as the minimum faculties that every person should cover in order to have a suitable and dignified permanence.

IEECP'23, July 11-12, 2023, 3rd European Conference

The quality of life in glacial areas of Peru is generally precarious and forgotten, cases like Puno where 90% of the population suffers from poverty and houses are not adapted to extreme climates., or Huaraz, where the conditions present in the houses generate a social gap and totally disregard the concept of quality of life, cases where the term survival is superimposed on comfort.

The city of Huaraz is located in the department of Ancash, it has an extension of 307.03km2 and a total population of 118,836 people, one of the usual problems in the area is the absence of houses that adapt to the climatic problems of the area. The extreme changing climate is a problem which directly affects the citizens of Hares, this is due to its location in the Andes, near glaciers. [1] [2]

The planned project is related to the tourism sector, which is a key player in achieving sustainable growth and raising awareness about climate change in the high Andean community of Huaraz [3][4]. The creation of a type of housing that protects the most needy by providing it with the necessary bioclimatic resources is a priority that is being neglected. One of the main generators of these environmental problems is the constant contamination present in the place, mainly generated by mining in the area, causing contamination with solid waste in the rivers that directly or indirectly negatively affects the city [5][6].

In addition, add about the adaptations to the changing climate produced by said contamination and analyze and delve into what in turn produces the melting of such famous glaciers; that is, a large hydrological imbalance in each respective basin [7][8]; negatively harming tourism due to its great cultural and natural value. This change was largely influenced by city-mountain interactions. Well, the mountainous areas, which at the beginning were destined for tourist purposes or protected areas, are experiencing changes in land use driven by demographic and socio-cultural urbanization, which is not only concentrated in valley floors, but also in high Andean areas that present more and more challenges for the sustainability of housing and the good quality of life of the inhabitants.[9] Taking into account the aforementioned, a proposal was made in which a series of bioclimatic strategies are proposed, mostly related to the thermal problems of the cold [10][11], particularly high in the chosen area, since it is the inhabited locality that exists more close to glaciers; without neglecting the other problems already mentioned and duly studied.

The objective of this research is to generate a project which, through architectural design strategies, allows a solution to the thermal comfort of Huaraz homes. Likewise, it seeks to do it in the most beneficial way in the monetary, environmental and social spheres that can be done, taking into account the area to be intervened and the future changes that this could generate.

II. LITERATURE REVIEW

A. Quality of life

Quality of life is the minimum faculty that every human being should have for the simple fact of living in an area, this fulfilling the objectives of sustainable development. [12] [13] [14].

B. Bioclimatic strategies

Bioclimatic strategies is the way to address a problem in the environment that prevents or hinders the design of a building and the comfort of the user within it. Seeking to take advantage of the climate and the conditions set by the environment in order to solve the above difficulties and arrive at a design that has thermal comfort inside[15], reaching its highest energy efficiency, on any day of the year without the need for mechanical systems or highly complex materials. [16] Mastering temperature, humidity, solar radiation, winds and precipitation. [17] [18]

C. Materiality

Regarding materiality, different variables were taken in order to arrive at the most beneficial, this being adobe or compacted earth. Due to their versatility, adobe and rammed earth are materials that can be adapted to many environments, both normal and extreme. [19] [20] Likewise, they have the characteristic that they are natural heat insulators, which in the context in which it is worked would be highly beneficial. The use of glass to generate greenhouses was also taken into account, these in a controlled context could generate a temperature control of the project.

III. METHODOLOGY

A. Methodological outline

The study of the problem was given through the analysis of the sources, arriving at a collection of data and later used in order to generate a response to the problem generated in the study area.

Figure 1. Methodological sequence

B. Place of study

The study site is located in the department of Áncash, province of Huaraz. It is located at the geographic coordinates 9°31'34" South latitude and 77°30'32.2" West longitude, with an altitude of 3050 meters above sea level. The Lot where the proposal will be made is located on the interoceanic highway, near the district of Nueva Florida.

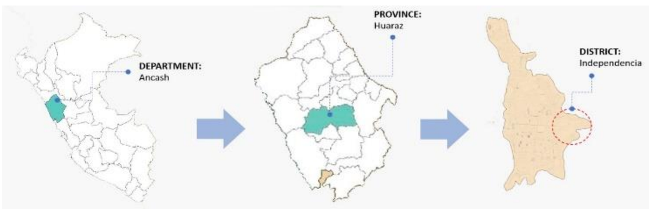

Figure 2. Map of the site to intervene. Huaraz Province, Ancash Department, Peru.

Figure 2 shows the general geographic location of the space to intervene, which will be in the city of Huaraz in Ancash, this area is characterized by the presence of glaciers and lagoons.

1) Climatology

Our study area, being in Huaraz over 2,600 to 3,800 meters above sea level, has a characteristic dry continental climate, being classified as a meso-Andean climate thanks to its location.

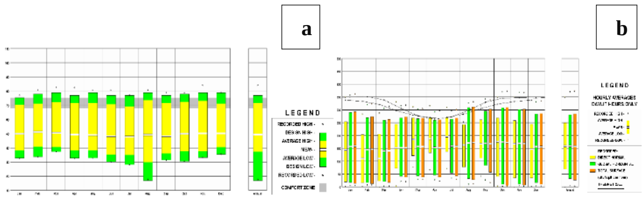

Figure 3. Radiation and Temperature Range Diagram

Figure 3(a) shows the temperature range present in Huaraz, in which it can be seen that comfort is not achieved in the average of the ranges in all the months. Having the minimum range in the month of August. In figure 3(b) the diagram shows how in the town of Huaraz there is an increase in radiation in the summer and spring seasons, reaching a maximum point in the month of September. Direct solar radiation in winter is frequent.

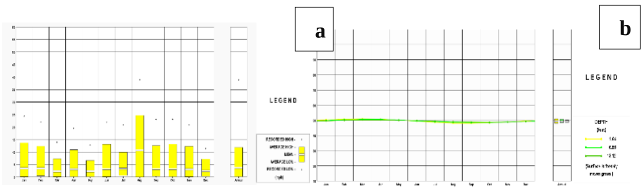

Figure 4. Wind Speed and Earth Temperature Diagram.

In Figure 4(a), the wind speed diagram helps to understand its behavior and the influence of the Huaraz environment on it. An influence of mountainous relief on the variation of the winds is observed and the presence of the Santo River favors the wind currents on the eastern shores. Figure 4(b) shows the maximum temperature of 13.12 feet, which would be 4 meters deep in the Huaraz land. It is obtained that the surface of the earth in this zone is mostly cool.

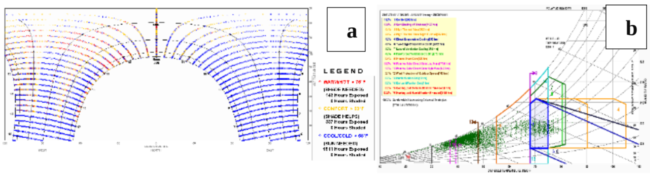

Figure 5. Sun Protection Chart and Psychometric Abacus.

In Figure 5(a), the table graphically shows sun exposure and shade needs depending on the degrees of temperature reached after exposure. The result of the study for the realization of this table shows that most of Huaraz has a need for sun after being below 20 ° C after 1611 hours of exposure. In Figure 5(b) of the exhaustive analysis of the psychometric abacus, the following points are rescued: to achieve a comfort zone, it is necessary in the months of June to December to generate an average temperature of 25.5°C with a humidity of 40% and to the internal gain heating is necessary to consider the electronic equipment used by the same residents to take into account at the time of thermal distribution.

2) Flora

Huaraz has a great variety of plants adapted to the cold and dry climate, with qualities to resist cold weather, water scarcity and great heights depending on how close it is to the glacier. 779 species of high Andean flora distributed in 340 genera and 104 families have been identified. Starting with the Achupalla (Puya angusta), Awinchu (Gaultheria brachybotrus, Yareta (Azorella yarita), Coñaq (Werneria dactylophylla) and Cuchi-cuchi or Curicasha (Matucana yanganucensis). In addition to having flower lagoons such as Escorzonera (Perezia multiflora) , Hatatsucku (Gentianella weberbaurei), Macha – macha (Pernettya prostrata) and the Mula Ishanca (Loasa grandiflora). Also inhabiting the well-known Ichu or Oqsha fern (Stipa ichu).

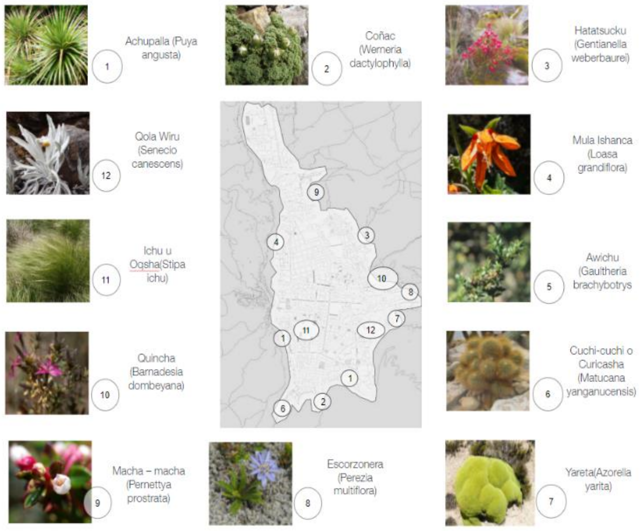

Figure 6. Wild representation of the area and their respective scientific names.

In Figure 6, the indicator shows some of the most predominant species in the wild flora of Huaraz, Ancash, accompanied by clear images, common names of the plants and the scientific names of each one of them for a better understanding and classification of the information. given. [21]

3) *Population*

According to the census carried out in 2017 in the province of Ancash in the province of Huaraz, the population of 164,004 inhabitants has been registered, of which 35% are between 0 and 19 years old, 53% between 20 and 59 years old, 12% are 60 or older and their population density is 30 inhab.km2. [22]

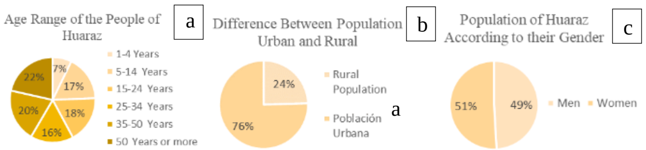

Figure 7. Graph of data obtained from the census INEI 2017

In Figure 7 the figure (a) made based on the population of Huaraz, shows a large percentage of presence of adults from 35 to 50 years with 20% and adults from 50 years and over, reaching 22%., while the population of children between 1 and 4 years old only represents 4% of the total population of our research area. [23] In figure 7(b) made based on the population of Huaraz, it is possible to observe a great and marked predominance of the urban population with 76% compared to the reduced percentage of 24% for the rural population.[24] This would indicate a possible increase in the urban population in the short term. In figure (c) made based on the population of Huaraz, information is collected on the percentage of 51% that represents the population of men compared to 49% that represents the percentage of the female population in our meso-Andean zone. [25] Having between them a very stressful difference in percentages of only 2% of the population to be studied.

4) *Land use*

Current situation, Interoceanic highwa

The Interoceanic highway that functions as the axis of our study area, is currently in a state of expansion due to the population growth of the town, so its finishes are not the most suitable, since it is unpaved and without correct signaling.

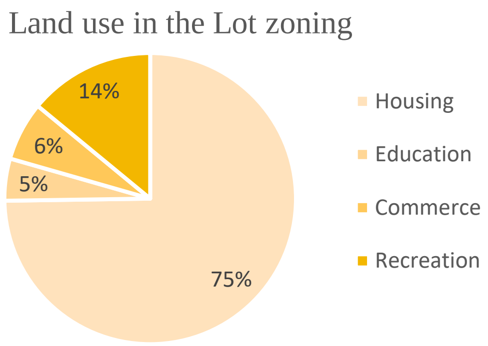

Figure 8. Graph of the land use of the environment of the chosen lot.

IV. RESULTS

A. Project location

The chosen lot is located on Calle Interoceanica, it has an approximate area of 13400m2 and is considered a typical area of the area, with uniform soil and climatic characteristics throughout the area, it is considered as a starting point for the realization of the proposal of typical house. Likewise, the low flow of vehicles and pedestrians can be seen, having a context where the houses that surround it are in very poor conditions, endangering the citizens of the area.

Figure 9. Road section of the selected sector

Figure 9 shows the route section which allows mobilization to the area to be intervened.

B. Batch characteristics

With an area of 13,400 m2, the selected lot has a trapezoidal shape and is located next to the interoceanic highway. In a populated town near the snowy Huantsan.

Figure 10. Dimensions of chosen lots

In Figure 10, the chosen lot measures 178m on its longest side and 60 meters on its narrowest side.

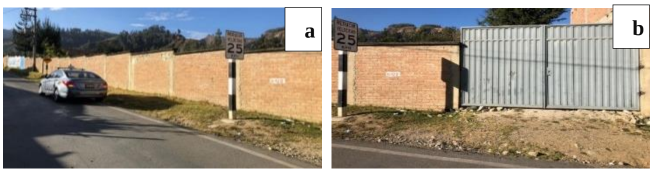

Figure 11. Images of the current terrain

In Figure 11, Figure (a) shows the length of the chosen land and how its topography is currently. In Figure (b) you can see the current entrance to the land and the vegetation found in the surroundings.

C. Volumetric proposal

A housing model will be presented which will later be distributed throughout the area giving more people the possibility of being part of the project. Finally, some images of the project that is being designed to combat the extreme and changing climate, generate an urban unit and a better quality of life are presented. [26] [27] [28].

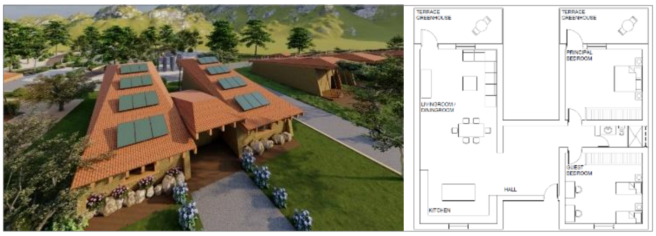

Figure 12. housing prototype

Figure 12 shows the typical single-level dwelling, with a U-shaped distribution of spaces. Which will later be replicated to generate a complex of rural dwellings located in our study area in the town of Huaraz, Ancash.

D. Construction Methods

In relation to the construction methods studied, it was concluded that 2 methods were used: the use of adobe houses and a construction method called rammed earth. The use of adobe has been imposed in the territory since ancient times, unfortunately the little value that is given to this method has caused it to be displaced and generalized as an old and inefficient method. In relation to the second construction method taken into account, the use of rammed earth could be mentioned, which consists of pressing the earth in different layers in order to generate walls which will later be houses, both this and the use of adobe are 2 solutions ecological due to how practical it is to be able to carry them out. [29] Thus providing added value to both in relation to meeting the SDGs.

Figure 13. Elements that make up the Adobe construction system.

In Figure 13, it is shown how the rammed earth system is managed, through a piston moist clay soil is compacted, in order to generate a wall which, having a predominant thickness that allows heat to be stored inside, serving as a thermal agent that safeguards those who are inside it.

E. Sun path

A solar tour was carried out on the proposal to analyze its behavior and predict lighting and solar energy that it will capture during the day.

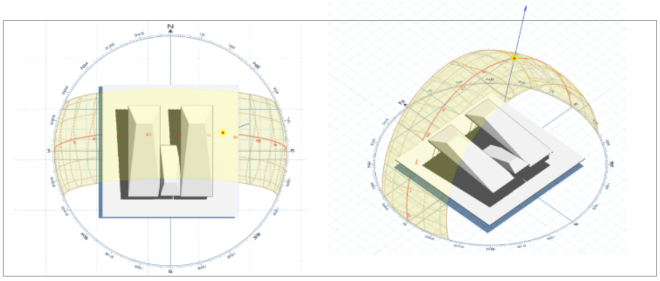

Figure 14. Solar route of the project located.

Figure 14 shows the solar path generated in the project located in the city of Huaraz.

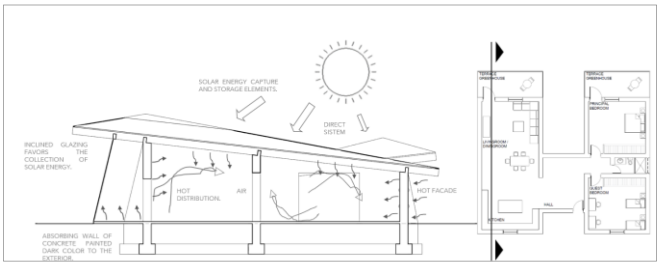

Figure 15. Collection, storage and distribution of thermal and wind energy.

In Figure 15, the cross section diagrams the behavior of the wind flow and the capture of thermal energy, either by passive energy capture systems or direct solar energy capture systems.

F. Design strategies

Six main design strategies were proposed:

1) *Hip roof.*

These are elements that allow water and accumulated waste to be eliminated and greater heat retention, in addition to regulating the heights of the walls maintaining the same degree of inclination compared to gable roofs.

2) Tree of the Tara

With the use of trees, we protect ourselves from the winds that come from the SSE and SW. In particular, the tara tree manages to trap greenhouse gases, purify the environment, and protect the other plants that live in its shade.

Figure 16. Explanatory drawing of the tara tree.

In Figure 16, the explanation of what this tara tree is and the benefits it brings to the other plants and buildings that decide to use it is deepened; as is the shadow it projects, since it is a tree with a crown of considerable density.

3) Attached Greenhouse.

These greenhouses function as large heat storage facilities under the effect of thermal mass, increasing the temperature of the home by up to 10°C with respect to the outside temperature.[30][31] [32]

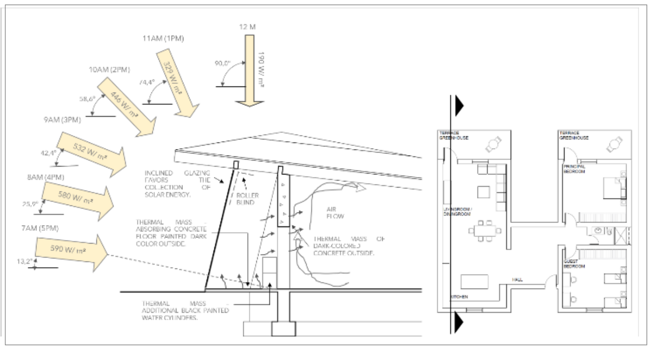

Figure 17. Solar radiation received by the vertical collector of a greenhouse in the month of April or August facing East (West).

In Figure 17, the scheme explains the behavior of the proposed house to solar radiation, sunlight received by the greenhouse in certain months, in addition to graphing the ventilation flow and the thermal distribution product of this thermal mass receiving energy implemented in the housing prototype proposed in this project.

4) Three-layer floor.

Refers to a floor made up of stone, air and wood. This allows you to isolate the heat from the ground, preventing the building from cooling down, as it acts as a separator so that the ground does not transmit your low temperature to the rest of the house. [33] [34] [35]

Figure 18. Structure of a three-layer soil.

In Figure 18, it is divided indicates the three divisions in which the structuring of the floor consists for the separation of the temperature transmittance of the floor to the house and the loss of heat from it.

5) Photovoltaic panel.

They are solar panels which are characterized by being generators of sustainable energy since they produce this electricity in the form of direct current, [36] [37] for this it is placed outside. [38] [39] [40] Will not be abused in its intended location because it was designed to withstand outdoor conditions. [41]

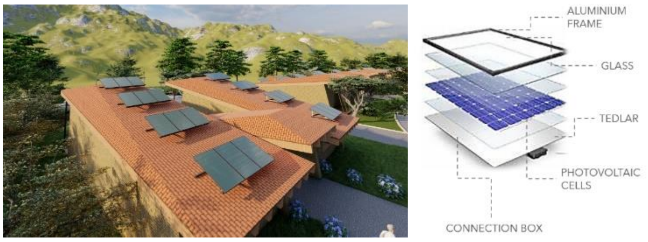

Figure 19. Photovoltaic energy used in the house in detail.

In Figure 19, it is being explained graphically which are the parts that make up a photovoltaic panel.

Table 1. Characteristics of the photovoltaic panel.

Characteristics of the photovoltaic panel.	
Photovoltaic Panel Performance	0.75
Solar Panel Power	300.00
Measurements	L*1000mm/A:998mm/G: 35mm
Thermal Characteristics	427+/-2°C
Solar Panel Cell Type	Monocristalino

Table 1 shows the characteristics of the photovoltaic panel for home use, which has a performance of 0.75, with a solar power of 300 and a monocrystalline cell type.

Table 2. Energy demand in the home.

To transmit to Kwh/día		
Wh/día	**Conversión**	**Kwh/día**
6882.75	1000.00	6.88
Kwh/día	**Dayli (Kwh)**	**Monthly (Kwh)**
6.88	30.00	206.48

Table 2 shows the daily and monthly energy demand necessary for the supply and lighting comfort in the home.

Table 3. Photovoltaic panel power.

HSP	work performance	Potencia Pico del Módulo	Module Power (Wh/día)
4.37	0.75	300.00	983.25

Table 3 shows the power given by each module of the monocrystalline photovoltaic panel.

Table 4. Calculation of photovoltaic panels.

Wh/día	Units	Wh/día
983.25	7.00	6882.75

Table 5. Sizing and number of solar panels

Number of solar panels needed		
Available roof area	7.00	m2
solar panel surface	1.00	m2
Number of modules	7.00	Unid.

Figure 20. Housing Complex Prototype

Figure 20 shows the proposal for a rural residential housing complex, using the standard housing as the base nucleus and located in such a way that it takes advantage of the greatest amount of solar energy and achieves the greatest heat capture within the building.

Figure 21. Dry gardens raised throughout the proposal for the housing complex.

In Figure 21, a 3D animation of the design of the dry gardens that were chosen to be used within the proposed housing complex is presented, due to its low need for maintenance, water, costs and better adaptation to the local climate, native plants were used. of the area, in addition to the rest area within the proposed housing complex, in addition to graphically presenting the use of photovoltaic panels also implemented to the light poles of the proposal.

Figure 22. Exterior view of proposed rural housing within the proposed residential complex.

In Figure 22, Figure (a) shows a 3D animation of one of the six type dwellings located within the residential complex, where the strategically located windows and the marked entrance to the dwelling can be observed. Figure 24 (a) presents a 3D animation of the square which will connect the different houses that are distributed throughout the complex.

V. DISCUSSION

This research has the objective of proposing a bioclimatic house that allows the comfort of users in a glacier zone that is based on an investigation that analyzes the climatic characteristics in Indonesia for the development of a standardized bioclimatic construction system through the analytical study of Based on local experiences, this climatic analysis recommended the use of wind penetration by natural penetration. The similarity with our project is how the construction method is designed to achieve thermal comfort for energy efficiency. [42] The transformation of automobile-dependent cities and rethinks the relationships between traffic and urban form with a focus on the integration of different modes of transport, this was key to the design of urban planning, the similarity with this project is how it relates to the urban environment. [43]

VI. CONCLUSIONS

Research associated with sustainable architecture seeks an insertion of constructions in the natural environment, with efficient use, analysis of thermal gain, comfort and life cycle of the natural resources required for its construction and operation, until its subsequent completion as Solid waste. In the case of the bioclimatic architecture used here, it focuses more than anything else on the profit and comfort of the user, as this is the main problem of the high Andean area of our chosen sector, accompanied by constant climate change, which is shown in the melting of glaciers, covers communities such as our study area and how to confront this problem in the most effective way and without harming or polluting the environment, taking advantage of all available resources.

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