VIRTUTIS INCUNABULA

Vol. 08, No. 1 (2021)

Temperature-Humidity Discomfort Index as Measure of Sensitivity in Addressing Vulnerability to the Effects of Climate Change of Selected Communities in Negros Occidental

Ashraf R. Khater[1], Mona Freda N. Secondes[1], Jude Xerxes M. Herbolario,[1] Carryl Joy P. Balinas[1], Anamae A. Lachica[1], Carmen C. Menes[2], Ismael A. Haguisan III[2], Theresa Jennifer H. Mendoza[2], and Josephine G. Lumagbas[2]

[1] University of Negros Occidental-Recoletos, Incorporated, Bacolod City, Philippines
[2] La Consolacion College-Bacolod, Bacolod City, Philippines

ABSTRACT

Temperature is the characteristic indicator of climate change. Understanding temperature effects in congruence with relative humidity can provide insight on how the ambient conditions can affect the community members. The study emphasized on using the Temperature-Humidity Discomfort Index (THDI) in characterizing the situation of each of the selected communities in the province of Negros Occidental. The THDI is a measure of sensitivity in assessing the vulnerability of the community members. The index was used as an indicator that would determine impacts on the community members, especially regarding their livelihood and their general well-being. The THDI thus is an eye-opener for the community members about the reality that climate change poses. Understanding the THDI that a community has can provide meaning on how the current conditions affect how they handle their daily tasks.

Keywords
climate change, vulnerability assessment, sensitivity, temperature, humidity, temperature-humidity discomfort index

INTRODUCTION

Climate change is characterized by the inherent increase of global temperatures in the recent century, with the sensitivity of biotic and abiotic systems being affected by such increase. According to Farrar and Gunn (2017), the effects of temperature have been known to provide long-term consequences, especially with the inability of systems to adapt and the need for societies to respond. The impact of temperature involves a holistic perspective, ranging from the fundamental physical influences to the physiological and the social.

In order to provide insight on the inherent impact of temperature, the use of the information together with the humidity of the current environment can provide meaning to why people experience certain levels of stress and how the physical environment affects their habitats.

Gasparrini et al. (2017) contended that temperature effects can influence mortality rates, and this is the prevailing situation that can disrupt human activity. What is essential is to evaluate how temperature levels can be presented and what actions the community members can take in order to address these rising temperature effects. Kellogg (2019) indicated that the pollution that humanity has contributed is a basis for the increasing global temperatures, since the culprit in this scenario is the carbon dioxide levels, which contribute to the steady increase of global temperatures.

Addressing temperature and humidity through

a specified index will give community members a qualitative insight based on the quantitative information presented. Oleson et al. (2015) noted that the use of the index is useful in policymaking and understanding how urbanization, heat stress, and the effects of climate change can be analyzed in the context of the ambient air conditions of temperature and humidity. Putting these together would give the necessary considerations that are aligned with addressing how heat stress can impact the welfare of people.

The focus of this study involved determining the Temperature-Humidity Discomfort Index of the selected communities in Negros Occidental, Philippines, namely Brgy. Cadiz Viejo, Cadiz City; Purok Seaside of Brgy. Tangub, Bacolod City; Purok Sambag of Brgy. Lopez Jaena, Murcia; and Barangay 40, Bacolod City.

Brgy. Cadiz Viejo is a coastal community that thrives on its fishing community as well as its tourism. The community has sufficient vegetative cover, and it is not as highly urbanized when compared to other communities. Brgy. Tangub is a coastal community, but unlike Brgy. Cadiz Viejo, it is highly urbanized. Minimal vegetative cover is present, and the houses are tightly packed in the community.

Purok Sambag of Brgy. Lopez Jaena, Murcia, is a rural, inland community that is found in the upper portion of the island of Negros. It is rural, where the vegetative cover has been sparse given the increased drought in the area. Brgy. 40 is an inland community that is highly urbanized with high house density due to the arrangements of households being adjacent to one another throughout the community. Very minimal vegetative cover is present.

By analyzing the Temperature- Humidity Discomfort Index and the insights drawn from the community members, a better understanding of the community's welfare may be paved in the hope of promoting proactive change through proper interventions and educations in addressing the inherent effects of climate change on the individuals involved.

METHODOLOGY

The Temperature-Humidity Index focuses on understanding empirical data and transforming it into qualitative information that would hold meaning for those who wish to understand their current environmental conditions. As noted by Oleson et al. (2015), the need to understand how urbanization is related to climate change through heat stress involves the utilization of indices that can understand why certain levels would provide discomfort to a given person. Discomfort, or in the case of environmental context, thermal discomfort, is a problem that can affect the living conditions of people, and even be involved in loss of productivity (Lan, Wargocki, & Lian, 2011). Moreover, increased temperature levels can result in problematic outcomes in terms of food scarcity and even social conditioning, wherein the overall welfare of the people would be compromised.

Specifically, the index works by analyzing temperature and humidity and then subjecting it to a standard interpretation to give insight on whether the values would provide a certain degree of discomfort to the people in the community. The equation (1) by Thom (1959) was adopted in order to understand the impact of temperature and humidity on the welfare of the people.

$$THDI = (0.8 * T_a) + \frac{T_a * RH}{500} \quad (1)$$

T_a or ambient temperature in degrees Celsius, and RH or relative humidity in percentage. To analyze the information attained, the table as presented in Table 1 by Md Din et al. (2014) was used.

Table 1
Interpretation of THDI

Quantitative Index Result	Qualitative Corresponding Result
THDI ≤ 14.9	Uncomfortable
15.0 ≤ THDI ≤ 19.9	Comfortable
20.0 ≤ THDI ≤ 26.4	Partially Comfortable
26.5 ≤ THDI	Uncomfortable

The values of the Temperature-Humidity Discomfort Index (THDI) involve a window of comfort being found between a value of 15 and 26.4. This is noted through the fact that extreme temperatures (both high and low) and extreme relative humidities (both high and low) are accounted for. Between 15.0 and 19.9, the interpretation is Comfortable, which can be evident through the right balance of temperature and humidity; between THDI values of 20.0 and 26.4, the situation is Partially Comfortable. For the analysis of the temperature and humidity of the given site, assessment was done through the use of an ambient temperature-humidity meter at the source points of water, since the vicinity of the water source is also the area wherein people would gather. Moreover, the analysis was done in triplicate so that it may be representative of the situation at hand. The analysis took place during the three-month period of data gathering, which are December 2018, January 2019, and February 2019. For Brgy. Cadiz Viejo, the point was 11° 0' 3.17386" N, 123° 11'57.7638" E. For Brgy. Tangub, the point was 10° 37' 52" N, 122° 55' 32" E. For Purok Sambag, Brgy. Lopez Jaena, Murcia, the point was 10° 34' 30.2" N, 123° 4' 27.12" E. Finally, for Brgy. 40, the point was 10° 39' 29.87" N, 122° 57' 7.32" E. The THDI was also assessed together with the sentiments of the community members, to give further insight on the realities that they have been experiencing due to the changes in the ambient temperature.

The limitation of the collection involved only wet-season analysis, so the analysis of the situation at present was defined within those parameters only.

RESULTS, DISCUSSION, AND IMPLICATIONS

The first site of analysis was Brgy. Cadiz Viejo, Cadiz City. During the first month of analysis, the average temperature was 32.3 ± 0.24 degrees Celsius and the average relative humidity was 42.67 ± 0.47%. The THDI for the first month was 29, which is interpreted as Uncomfortable. The high temperature is noted through the current conditions being that no precipitation occurred during the week of analysis and the conditions were dry. During the second month of analysis, the average temperature was 26.29 ± 0.02 degrees Celsius and the average relative humidity was 78.99 ± 0.06%. The THDI for the second month was 25, which is interpreted as Partially Comfortable. The rainy season is at its saturation and the community has experienced rainfall during the timeframe of the data gathering. During the third month of analysis, the average temperature was 27.09 ± 0.06 degrees Celsius and the average relative humidity was 76.37 ± 0.35 %. The THDI for the third month was 26, which is interpreted as Partially Comfortable. The community still experienced rains and the conditions were windy during the time of data gathering. Overall, an improvement of the THDI was noted, which explained the improved physical environment conditions in the community. Vegetation cover is an important indication of the THDI, wherein an improvement of vegetation would result in the improvement of THDI (Ige, Ajayi, Adeyeri, & Oyekan, 2017). In the case of Cadiz, the improvement of the THDI is attributed to the vegetation cover that is evident across the whole

area, which is also noted to improve because of the condition that is present in the given community and the nature of rainfall.

The second site of analysis was Purok Seaside of Brgy. Tangub. During the first month of analysis, the average temperature was 32.9 ± 1.27 degrees Celsius and the average relative humidity was 51.67 ± 3.86%. The THDI for the first month was 30, which is interpreted as Uncomfortable. No precipitation occurred during the date of data gathering. During the second month of analysis, the average temperature was 26.83 ± 0.62 degrees Celsius and the average relative humidity was 78.33 ± 0.47 %. The THDI for the second month was 26, which is interpreted as Partially Comfortable. Wind was noted during the time of data gathering which may have resulted in the lower temperature; however, the relative humidity was high due to the presence of rain during the week of the data gathering. During the third month of analysis, the average temperature was 31.84 ± 0.54 degrees Celsius and the average relative humidity was 54.61 ± 2.79 %. The THDI for the third month was 29, which is interpreted as Uncomfortable. Overall, the THDI of the community did not improve. A slight improvement was noted in the second month, but the dip in the third month indicated that, from a physical environment perspective, the conditions were not comfortable to the community members. Jandaghian and Akbari (2018) explained that urban settings are known to have higher temperature readings due to the way the buildings are structured. In this perspective, even though the community is adjacent to a body of water, the inherent

The third site of analysis was Purok Sambag of Brgy. Lopez Jaena, Murcia. During the first month of analysis, the average temperature was 28 ± 0.41 degrees Celsius and the average relative humidity was 70 ± 0.82 %. The THDI for the first month was 26, which is interpreted as Partially Comfortable. The site was dry and a breeze was noted during the time of the data gathering. During the second month of analysis, the average temperature was 28.99

± 0.005 degrees Celsius and the average relative humidity was 65.64 ± 0.28 %. The THDI for the second month was 27, which is interpreted as Uncomfortable. While there is sufficient vegetative cover, the community had more areas of direct sunlight, which may attribute to the index outcome as noted. During the third month of analysis, the average temperature was 31.70 ± 0.23 degrees Celsius and the average relative humidity was 49.73 ± 0.48 %. The THDI for the third month was 28, which is interpreted as Uncomfortable. Overall, the THDI of the community did not improve. The direct sunlight resulted in the inherent outcome of the THDI which proved to be uncomfortable for the community members.

The fourth site of analysis was Brgy. 40. During the first month of analysis, the average temperature was 30 ± 0.82 degrees Celsius and the average relative humidity was 64.67 ± 0.47 %. The THDI for the first month was 28, which is interpreted as Uncomfortable. The site had experienced no rain at the time of the data gathering. During the second month of analysis, the average temperature was 28 ± 0.41 degrees Celsius and the average relative humidity was 64.5 ± 0.41%. The THDI for the second month was 26, which is interpreted as Partially Comfortable. The weather conditions during the time of data gathering were dry with bursts of wind. During the third month of analysis, the average temperature was 32.68

± 0.08 degrees Celsius and the average relative humidity was 56.39 ± 1.15 %. The THDI for the third month was 30, which is interpreted as Uncomfortable. Overall, the THDI of the community did not improve. The highly-urbanized nature of the site contributed to the non-improvement of the conditions, and this has presented the potential concern for adapting to the temperatures and humidity values in the community.

The analysis of these results, as noted by Oleson et al. (2015) acts as a foundation toward

understanding how urbanization can affect the welfare of the people involved. Poorer outcomes were noted in the communities that have been urbanized (Tangub and Brgy. 40). While, for rural communities and non-urbanized communities, the outcomes varied and depended on the pertinent conditions at hand. Mushore, Odindi, Dube, and Mutanga (2018) conducted the thermal discomfort analysis measures that would likewise influence the notion that temperature influences people's welfare in a multifactorial sense, which would result in a compromise of the condition.

In terms of the insights from the residents, the following can be noted. A member of the community at Cadiz Viejo noted that the weather has significantly changed over the years, especially given the fact that the member remarked on the intensive heat given that the community has limited vegetative cover to mask the direct sunlight impact. For the community of Tangub, one member noted that summertime is especially troublesome since the weather is too hot. In Purok Sambag, Lopez Jaena, Murcia, the respondents mentioned that the heat has affected their crop and even their living condition; the respondents noted that the heat is painful on the skin, and they remarked that the dry seasons are especially painful to bear. For the residents of Brgy. 40, they all mentioned that the heat is something they did not expect, and they even remarked headaches and other bodily pain that they attribute to the heat.

CONCLUSION AND RECOMMENDATIONS

These insights show the reality of how temperature can affect the people of the communities. The current condition should be looked into in terms of proper adjustment of lifestyle and introduction of measures to improve the conditions of the people, especially given the rising threat of climate change. The situation of temperature and the comfort that it entails presents a long-term effect on the impacts that climate change would bring. The next steps to take in developing a holistic picture is to conduct further analyses on the temperature-discomfort environment, so that more perspectives may be done. Climate change continues to affect the society in a multitude of ways. It is important to be able to maintain continuity at hand, especially in the effort of considering the impact of climate change on the social environment.

ACKNOWLEDGMENT

This research is an output from the VALUE Negros Project of the University of Negros Occidental – Recoletos and La Consolacion College Bacolod and funded by the Philippine Government through the Commission on Higher Education (CHED) Discovery Applied Research for Trans- Interdisciplinary Opportunities (DARE- TO).

REFERENCES

Farrar, J. F., & Gunn, S. (2017). Effects of Temperature and Atmospheric Carbon Dioxide on Source-Sink Relationsin the Context of Climate Change. In *Photoassimilate Distribution Plants and Crops Source-Sink Relationships* (pp. 389-406). Routledge.

Gasparrini, A., Guo, Y., Sera, F., Vicedo- Cabrera, A. M., Huber, V., Tong, S.,... & Ortega, N. V. (2017). Projections of temperature-related excess mortality under climate change scenarios. *The Lancet Planetary Health*, *1*(9), e360-e367.

Ige, S. O., Ajayi, V. O., Adeyeri, O. E., & Oyekan, K. S. A. (2017). Assessing remotely sensed temperature humidity index as human comfort indicator relative to landuse landcover change in Abuja, Nigeria. *Spatial Information Research*, *25*(4), 523-533. https://doi.org/10.1007/s41324-017-0118-2

Jandaghian, Z., & Akbari, H. (2018). The effects

of increasing surface reflectivity on heat-related mortality in Greater Montreal Area, Canada. *Urban Climate*, *25*, 135-151.

Kellogg, W. W. (2019). *Climate change and society: consequences of increasing atmospheric carbon dioxide*. New York: Routledge.

Lan, L., Wargocki, P., & Lian, Z. (2011). Quantitative measurement of productivity loss due to thermal discomfort. *Energy and Buildings*, *43*(5), 1057-1062. https://doi.org/10.1016/j.enbuild.2010.09.001

Md Din, M. F., Lee, Y. Y., Ponraj, M., Ossen, D. R., Iwao, K., & Chelliapan, S. (2014). Thermal comfort of various building layouts with a proposed discomfort index range for tropical climate. *Journal of Thermal Biology*, *41*, 6–15. https://doi.org/10.1016/j.jtherbio.201 4.01.004

Mushore, T. D., Odindi, J., Dube, T., & Mutanga, O. (2018). Outdoor thermal discomfort analysis in Harare, Zimbabwe in Southern Africa. *South African Geographical Journal*, *100*(2), 162-179. https://doi.org/10.1080/037 36245.2017.1339630

Oleson, K. W., Monaghan, A., Wilhelmi, O., Barlage, M., Brunsell, N., Feddema, J., ... & Steinhoff, D. F. (2015). Interactions between urbanization, heat stress, and climate change. *Climatic Change*, *129*(3-4), 525-541. https://doi.org/10.1007/s10584-013-0936-8

Thom, E. C. (1959). The discomfort index. *Weatherwise*, *12*(2), 57-61. https://doi.org/10.1080 /00431672.1959.9926960