Review Paper:

Drought and Public Health Challenges: Analysing causations and interventions

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Abstract

Water stress, occasioned by irregular and insufficient rainfall, has been found to have far-reaching impacts on human lives and livelihoods. Often, these impacts have been linked to agriculture, industry and household water needs. In transcending these usual narratives about drought impacts, this study attempts to discuss the drought-health nexus which is an area of scholarship that has not gained much attention.

Relying on extant literature as data source and content analysis as analytical tool, the study highlights the impacts of drought on public health. The study recommends early warning systems (EWSs), scenario planning (SP) etc. as interventions which can ameliorate the impacts of drought on public health.

Keywords: Adaptation, drought, public health, vulnerability, adaptation

Introduction

Drought is a condition induced by climate variability which results in rainfall deficiencies.[12,18,32] It is one of the climate change realities confronting our world today. Already, dry lands cover one-fifth of the world's land area and the expectation is that drought will worsen in rate and intensity in the future.[28] Drought thus worsens the already precarious conditions homes, homesteads and industrial activities in arid areas are exposed to. For instance, during the 1999 drought, according to Sohl et al,[28] Syria lost almost half of its wheat and barley harvests. In 1997, Jordan slaughtered one-third of its national livestock because of severe and prolonged drought.

Drought may be looked at from five angles namely meteorological, agricultural, hydrological, socio-economic and ecological drought.[22] Meteorological drought is said to be occurring when rainfall falls below normal, long term recorded level. Agricultural drought occurs when soil moisture is insufficient to meet the needs of crops in a given farming season. Hydrological drought occurs when there is deficiency of water supply due to reduction in or absence of surface and subsurface water. Socio-economic drought results when human socio-economic activities are impaired as a result of reduced rainfall and/or water availability.[19,23] Ecological drought derives from the stress and threat faced by the ecosystem because of drought. The definition of drought is often linked to dry period caused by unpredictable, or absence of rainfall.[12,18,32] Extended rainfall deficiency which results in water shortage for all water-requiring activities and uses is thus seen as the causative factor for the outset of drought. However, other schools of thought have advanced an antithesis that is a critique of rain-deficit explanation. Their argument is hinged on the insufficiency of a single index to account for why there is an outset of drought. They believe that emphasis should be placed on the significance of increased atmospheric temperature as a driver of droughts also.[10,30]

The locus of this argument is that increased evapotranspiration - evaporation from free water and transpiration from plants – and precipitation (rainfall) shortage create a drought situation. However, overwhelmingly, the scholarship community on drought favours rain deficiency as the only factor responsible for the occurrence of drought. A counter criticism against evapotranspiration argument is that atmospheric temperature has already been factored into normal climatic condition.[22] There is also the question of the effect of temperature in a drought situation where there is anomalously low atmospheric temperature and a corresponding anomalously low rainfall.

Drought occurrence may be short-term, meaning, recurring for few weeks, or long-term, that is, becoming protracted for years before climate conditions return to normal and standard levels. When drought protracts for years, its effects may be distressing on water supplies for all water uses. As should be expected, the impacts of drought tell on agricultural activities and rural/agrarian communities because of high dependence on water for economic and domestic activities. Drought, for instance, affects crop production because of inadequacy of moisture available at the right time for the growth and maturation of crops.[14] It is noteworthy however that the effects of drought transcend agricultural, industrial and domestic water stress. This review paper therefore looks at the impacts of drought on public health and well-being.

The concept of Public Health

United States' Centre for Disease Control Foundation defines public health as the science of protecting and improving the health of people and their communities.[8]

Generally, the focus of public health is the protection of the health of the entire population. The core components of public health include the following: health, population,

society-wide concerns and vulnerable population.[27] Health refers to the general, physical well-being of all individuals living in any given society. Population is the total number of people living within a marked community. This could be a small local community, an entire country and it may even be a region of the world.

The idea of population presupposes that there is some boundary that demarcates a people from another people. It must however be mentioned that boundary has little or no effect when there is a disease outbreak of an infectious nature. This is because of inter-boundary migration that exists among societies. For instance, the current Covid-19 pandemic defies national boundaries. The third component, society-wide concerns, presupposes that a public health issue is that which affects an appreciable number of people living in a society and which has drawn health and well-being concerns from most people living in that society. Vulnerable population will be those individuals who are at risk of any health crisis.

Drought and public health issues: Review of Literature

Drought, as an environmental security challenge, has been argued to lead to exposure to health and/or personal hazards such as diarrhea, cholera and dysentery as a result of water scarcity which forces people to drink water from unhygienic sources.[6,26] The essentiality of water to life requires that individuals living in drought-affected areas must source it regardless of whether it is healthy or not. This is one of the challenges that water stress from climate variability portends. Similarly, a research finding by Achakulwisut et al[1] linked drought to soil-derived particles in the Southwest of the United States that endangers air quality which may lead to significant public health problems. Air pollution is a leading cause of respiratory and cardiovascular diseases, reproductive and central nervous system dysfunctions and cancer.[4,20,31]

There is scholarly evidence in literature linking drought to *in-utero* exposure, that is, the exposure of yet-to-be-born children to environmental hazards which may negatively affect their health when they are born and educationally, later in life.[3,5] These studies put forward the fact that the conditions in pre-birth period and early childhood have an enduring impact on life expectancy, earnings, adult health and cognitive development. They used famine and extreme weather shocks to estimate instrumental relationship between the *in-utero* exposure and later-life conditions and life-chances.[3,5]

Some scholars have also argued that parts of the multiple health impacts of drought, which are often not recognised, are vector-borne diseases, nutritional problems and mental health conditions.[17,21,26] Initially, the linkage between mental health condition and the phenomenon of drought was merely speculative rather than based on empirical evidence. The World Health Organisation[33] had posited that mental health resilience - the capability to cope with harsh conditions and to avoid mental health challenges when threatened by stressors - can come under uncontrollable stress in the presence of sustained drought. The WHO's position, however, was not backed by an empirical data. The quantification of the linkage between mental health conditions and drought phenomenon by O'Brien et al[21] is perhaps one of the most significant contributions made so far on the discourse around the impacts of drought.

In a study carried out by O'Brien et al[21] in Australia which used household, income and labour dynamics in Australia to determine the relationship between drought and mental health condition, the results revealed that during a seven-year period of major and pervasive drought, one pattern of relative dryness (extreme cumulative number of months in drought culminating in a recent period of dryness lasting a year or more) was connected with greater distress for rural but not urban dwellers. The increase in distress was said to be at 6.22% based on 95% confidence intervals, therefore the study showed the possibility of quantification and identification of the relationship between patterns of drought and mental distress.

From the foregoing, drought portends serious health challenges to vulnerable population in drought-prone areas. Its scale and magnitude when it occurs will determine the degree of vulnerability of human population living within drought-affected areas. Its impacts on health however depend on the level of preparedness of individuals living in drought-prone corridor in pre-drought season and the degree of responsiveness at its outset.

Recommended Interventions

Early warning systems: This is a critical management tool identified by scholars whose interest is aligned to drought management especially as it concerns water resources for forage, for crop production and livestock activities respectively. The crux of early warning systems (EWS) is early detection of time series, out-of-pattern deviation which may indicate the likelihood of occurrence of a situation. With regards to drought, it is about looking out for unusual trends with a view to immediately addressing them with respect to the manifestations of water deficiency. For example, Camarero et al[7] argued that indiscernible or declining growth of trees or their mortality may signal the outset of drought and afford an opportunity for counteracting or mitigating the problems attendant upon it.

Early warning interventions can ensure disaster risk reduction while at the same time facilitating the meeting of goals of adaptation to changes in extreme climatic events.[25] The necessity for the EWS owes largely to the fact that drought is a complex phenomenon which requires a comprehensive approach that would consider numerous indicators required for drought monitoring and early warning.[16] The norm has always been that most countries and regions usually resort to reactive, crisis-driven approach

because of absence of early warning systems which are critical to integrated risk assessment and management protocols.

Early warning systems are veritable tools for alleviating the issues connected to drought, especially water scarcity and improving resilience against the consequences of drought.[17] Effective early warning systems (EWSs) are also important because water supply augmentation may also require several years of planning and huge capital investments before the intervention yields the desired result in terms of water availability.[17] As a way of responding to these challenges, Governments may develop cope mechanisms and strategies to promote water conservation, water efficiency and alternate water resources.[17]

Scenario planning: This is another critical management tool with regards to water demand and supply management.[2,15,17] Scenario planning model is advantageous in terms of guiding the development of scenarios that generate a wide spectrum of projections of future water demand and supply.[17] The way this works is that there is already a future projection in place which is then combined with a set of well-constructed scenarios representing a spectrum of plausible evaluation of future risks and the conception and advancement of mitigation and adaptation options and strategy.[17]

There are two important methods of planning scenario namely: demand scenario and supply scenario. Demand scenario is an approach which focuses on domestic water consumption as it estimates the water consumption vis-à-vis the combination of criteria relating to water as a basic need and as subject to economic demand or willingness to pay. On the other hand, supply scenario is basically targeted at looking at possible available water sources to fulfil the demand of water from three major water-dependent sectors: domestic, agricultural and industrial.

The thrust of scenario planning is simply about future scenario of climate change which may lead to water stress and which may hamper the supply of water to meet domestic, agricultural and industrial needs. Kumar et al[17] posited that the demand side drivers usually have a much stronger impact on water management than supply-side factors, meaning that water demand for all types of users, at any given time, often puts enormous pressure on the sources available to meet them. In essence, scenario planning affords water users and Government some opportunity to plan towards water scarcity.

Seasonal climatic predictions: The menacing impacts of drought on human lives, crop production, livestock, forage and water resources in general necessitated the introduction of seasonal climatic predictions. The thrust of this drought management tool – seasonal climatic predictions (SCPs) - is the anticipation and preparation for drought and how to adequately mitigate its impacts.[11,13,24,29] These predictions provide another supplementary tool needed to prepare for drought. Crimmins and McClaran[9] argued that those predictions have largely improved in recent decades, especially as they concern winter rainfall predictions because of connections with sea surface temperature and pressure anomalies that show up during El Niño Southern Oscillation events. They however submitted that these predictions are heuristic and useful, they are not a panacea to drought and the threats it posed. They surmised that seasonal climatic predictions are better seen as a relevant tool among other tools to advance preparation for future occurrence of drought.

One of the most reliable indices adopted by SCPs to predict climate phenomena is tracking and making attempts to forecast the state of the El Niño- Southern Oscillation (ENSO) which is a reasonably predictable, regular (on the order of 2-7 years) shift in sea surface temperatures along the equator of the Pacific Ocean basin.

More often than not, temperatures tend to be cooler in the eastern Pacific and warmer in the western Pacific as a result of easterly winds triggering upsurge of cool water in the east and the movement of warmer surface water to the west. According to Crimmins and McClaran,[9] some years that have the easterly winds stronger than average will support this pattern of cool east-warm west sea surface temperatures, which is often referred to as a La Niña phenomenon. It is a usual occurrence during El Niño events that these easterly winds weaken, thus prompting warm water to slosh back to the eastern and central Pacific with warmer than average sea surface temperatures in these regions.

Government intervention: In order to forestall the vagaries of drought on the health of vulnerable individuals, national or provincial government may support the migration of people from areas with chronic drought to areas with slight rainfall deficit or areas not experiencing it. Usually, people are not open to leaving where they are familiar with and relocating to another place except they will fare well in a new location. So, rather than relocate during chronic drought, they may just decide to weather the situation and wait it out.

However, if Government could provide shelter, economic and logistic support and health services in the temporary locale, a lot of the people who otherwise would have been exposed to health issues trailing drought, would opt for relocation. In the same vein, for people that may not want to leave because of sentimental attachments, Government may need to help with water distribution, health services, relief materials etc. to enhance their adaptation to the water stress occasioned by drought. It is needless to say that public health is at the core of Governmental responsibility.

Conclusion

Drought as a phenomenon is one of the realities of climate change that the world will have to grapple with for a long

time. Its multifarious impacts have become a locus of research. This study, relying on extant literature, has explored the nexus between drought and human health. It is clear that drought and indeed, climate change have significant impacts on public health. The recommended interventions, if implemented, may help to lessen the impacts of public health challenges that are associated with drought.

References

1. Achakulwisut P., Anenberg S.C., Penn S.L., Neumann J., Crimmins A.R., Fann N. and Mickley L.J., Linkages between drought and dust in the US Southwest: Implications for air quality and public health under future climate change, In AGU Fall Meeting Abstracts, GH12A-09 **(2018)**

2. Alcamo J. and Gallopín G., Building a 2nd generation of world water scenarios, UN World **(2009)**

3. Almond D., Edlund L. and Palme M., Chernobyl's subclinical legacy: prenatal exposure to radioactive fallout and school outcomes in Sweden, *The Quarterly Journal of Economics*, **124(4)**, 1729-1772 **(2009)**

4. Babadjouni R.M., Hodis D.M., Radwanski R., Durazo R., Patel A., Liu Q. and Mack W.J., Clinical effects of air pollution on the central nervous system; a review, *Journal of Clinical Neuroscience*, **43**, 16-24 **(2017)**

5. Banerjee A., Duflo E., Postel-Vinay G. and Watts T., Long-run health impacts of income shocks: Wine and phylloxera in nineteenth-century France, *The Review of Economics and Statistics*, **92(4)**, 714-728 **(2010)**

6. Calow R.C., MacDonald A.M., Nicol A.L. and Robins N.S., Ground water security and drought in Africa: linking availability, access and demand, *Groundwater*, **48(2)**, 246-256 **(2010)**

7. Camarero J.J., Gazol A., Sangüesa-Barreda G., Oliva J. and Vicente-Serrano S.M., To die or not to die: early warnings of tree dieback in response to a severe drought, *Journal of Ecology*, **103(1)**, 44-57 **(2015)**

8. Centre for Disease Control Foundation, What is Public health? https://www.cdcfoundation.org/what-public-health, accessed on 3rd May, 2021 **(2021)**

9. Crimmins M., McClaran M., Hall A. and Brischke A., Rain Gauges for Range Monitoring: Codeveloping Tools and Best Practices for Ranch-Scale Drought Detection, In 99th American Meteorological Society Annual Meeting, AMS **(2019)**

10. Dai S., Shulski M.D., Hubbard K.G. and Takle E.S., A spatiotemporal analysis of Midwest US temperature and precipitation trends during the growing season from 1980 to 2013, *International Journal of Climatology*, **36(1)**, 517-525 **(2016)**

11. De Felice M., Soares M.B., Alessandri A. and Troccoli A., Scoping the potential usefulness of seasonal climate forecasts for solar power management, *Renewable Energy*, **142**, 215-223 **(2019)**

12. Dracup J.A., Lee K.S. and Paulson Jr. E.G., On the statistical characteristics of drought events, *Water Resources Research*, **16(2)**, 289-296 **(1980)**

13. Freire J.L. et al, To what extent biomass burning aerosols impact South America seasonal climate predictions?, *Geophysical Research Letters*, **47(16)**, e2020GL088096 **(2020)**

14. Glantz M.H., Drought in Africa, *Scientific American*, **256(6)**, 34-41 **(1987)**

15. Haasnoot M. and Middelkoop H., A history of futures: a review of scenario use in water policy studies in the Netherlands, *Environmental Science & Policy*, **19**, 108-120 **(2012)**

16. Hayes M.J., Svoboda M.D., Wardlow B.D., Anderson M.C. and Kogan F., Drought monitoring: Historical and current perspectives, Drought Mitigation Center Faculty Publications, 94 **(2012)**

17. Kumar S., Molitor R. and Vollmer S., Drought and early child health in rural India, *Population and Development Review*, **42(1)**, 53-68 **(2016)**

18. McKee T.B., Doesken N.J. and Kleist J., The relationship of drought frequency and duration to time scales, In Proceedings of the 8th Conference on Applied Climatology, **17(22)**, 179-183 **(1993)**

19. Mishra A.K. and Singh V.P., A review of drought concepts, *Journal of Hydrology*, **391(1-2)**, 202-216 **(2010)**

20. Nardocci A.C., Freitas C.U.D., Ponce de Leon A.C. and Junger W.L., Air pollution and respiratory and cardiovascular diseases: a time series study in Cubatão, São Paulo State, Brazil, *Cadernos de Saude Publica*, **29(9)**, 1867-1876 **(2013)**

21. OBrien L.V., Berry H.L., Coleman C. and Hanigan I.C., Drought as a mental health exposure, *Environmental Research*, **131**, 181-187 **(2014)**

22. Oladejo A.O., Drought and Human Security in South Africa, An Analysis of Participatory Resource Governance, Unpublished Ph.D. Thesis, University of Zululand **(2020)**

23. Olagunju T.E., Drought, desertification and the Nigerian environment: A review, *Journal of Ecology and the Natural Environment*, **7(7)**, 196-209 **(2015)**

24. Parton K.A., Crean J. and Hayman P., The value of seasonal climate forecasts for Australian agriculture, *Agricultural Systems*, **174**, 1-10 **(2019)**

25. Pulwarty R.S. and Sivakumar M.V., Information systems in a changing climate: Early warnings and drought risk management, *Weather and Climate Extremes*, **3**, 14-21 **(2014)**

26. Sena A. et al, Indicators to measure risk of disaster associated with drought: Implications for the health sector, *PloS One*, **12(7)**, e0181394 **(2017)**

27. Sheikh A.F., What are the implications of each of the four components of public health?, https://medium.com/@faizan81/what-are-the-implications-of-each-of-the-four-components-of-public-health-26a1e6c198cc, accessed on 3rd May, 2021 **(2019)**

28. Sohl T.L. et al, Spatially explicit modeling of 1992–2100 land cover and forest stand age for the conterminous United States, *Ecological Applications*, **24(5)**, 1015-1036 **(2014)**

29. Tarchiani V., Pasqui M., Parrish P., Rapisardi E., Giuseppe E.D. and Baldi M., Learning and teaching about seasonal climate forecasts: a Mediterranean educational experience toward operational climate services, *Advances in Science and Research*, **15**, 257-262 **(2019)**

30. Vicente-Serrano S.M., Beguería S. and López-Moreno J.I., A multiscalar drought index sensitive to global warming: the standardized precipitation evapotranspiration index, *Journal of Climate*, **23(7)**, 1696-1718 **(2010)**

31. Vizcaíno M.A.C., Gonzalez-Comadran M. and Jacquemin B., Outdoor air pollution and human infertility: a systematic review, *Fertility and Sterility*, **106(4)**, 897-904 **(2016)**

32. Wilhite D.A. and Glantz M.H., Understanding: the drought phenomenon: the role of definitions, *Water International*, **10(3)**, 111-120 **(1985)**

33. World Health Organization, Promoting mental health, Concepts, emerging evidence, practice (Summary Report), Geneva, World Health Organization, Department of Mental Health and Substance Abuse **(2004)**.

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