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Summary of the first Brazilian Symposium on Human Biometeorology

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As in many other countries worldwide, human health in Brazil has been affected and will be affected by climate change in multiple ways. Such impacts will likely be exacerbated due to deficiencies in the national healthcare system. In this context, extreme heat can severely burden the most vulnerable population, necessitating associated risk assessment. This issue is exemplified in a study on heat stress vulnerability in six Brazilian metropolitan areas, showing that heat stress risk is higher where socio-economic conditions are the worst, particularly in less developed city areas (Lapola et al., 2019). Heat stress is a serious concern outdoors to agricultural and construction workers, who are frequently exposed to extreme weather conditions. Estimates from the Lancet Countdown 2020 report on health and climate change showed that only in 2019, Brazil lost 4.0 billion work hours due to excess heat versus 2.8 billion in 2000 (Watts et al., 2021). Therefore, urgent measures are needed to diminish risks related to working in outdoor environments and mitigate the impact of heat stress.

This brief background highlights Brazil as a ‘climate-health hotspot’, i.e. a country where climate affects local populations negatively through multiple pathways (Di Napoli et al., 2022). Knowledge gaps still need to be filled concerning the various climate-related dimensions of tourism, vector-borne diseases, mortality and morbidity in urban centers in the country (Krüger et al., 2022). Motivated by this, the first Brazilian Symposium on Human Biometeorology (*Simpósio Brasileiro de Biometeorologia Humana 2022*) was organized and held at the Federal University of Rio Grande do Norte (UFRN) in Natal, northeastern Brazil, between July 4 and 8, 2022.

The symposium was organized as a hybrid event by a committee composed of researchers acting in different regions of the country, and who had an ongoing research collaboration on matters related to human biometeorology. The event was partly sponsored by the ISB and partly self-supported by the organizers and institutions involved. The symposium aims to promote the development of the research area on human biometeorology in Brazil in facing challenges imposed by a globally and locally changing climate. To achieve this, the symposium focused on five main topics of discussion: a) climate-driven diseases; b) thermal comfort, urban and architectural biometeorology; c) atmospheric pollution and health; d) climate change; e) climate, health and climate change. This summary highlights the main findings, future research directions, and policy implications in each topic from the presentations and panel discussions.

Climate-driven Diseases

Regarding climate-driven diseases, the presentation discussed evidence of climatic influences on human health. The keynote speaker, Pablo Fernández de Arroyabe (Universidad de

Cantabria; former president of the International Society of Biometeorology - ISB) set the stage for the subsequent talks focusing on the influence of atmospheric processes on human health in the framework of climate-dependent diseases. Marcelo de Paula Corrêa (IRN-UNIFEI, Minas Gerais) introduced an interesting concept, the ‘exposome’. Exposome combines the effect of diverse impacts on human health from intrinsic factors (lifestyle and personal habits) and extrinsic factors (UV radiation, temperature and humidity, and pollution). In Latin America, land-use consequences on environmental degradation and the proliferation of vector-borne diseases are a matter of concern. As highlighted in the keynote speech, the relationship between atmospheric processes, climate change, and health needs to be better understood through transdisciplinary work. The local population needs to be informed by customized warning systems integrating monitoring systems, global data sources, innovative models, and GIS data.

Thermal Comfort, Urban and Architectural Biometeorology

On the interplay between thermal comfort, urban and architectural biometeorology, nature-based solutions are crucial to curb heat stress in cities and rural areas. The keynote speaker, Cho Kwong Charlie Lam (Sun Yat-sen University, Zhuhai, China), focused on outdoor environments and examined the multisensory interaction of diverse factors regarding environmental quality and perception. Of particular interest to the climate-responsive design, urban greenery was proposed as a feasible solution to improve thermal and visual comfort, concurrently reducing noise levels and air pollution in urban areas. Other speakers, such as Loyde Abreu-Harbach (Universidade Mackenzie, São Paulo), also stressed the adequate deployment of green infrastructure in urban areas. Abreu-Harbach addressed the benefits of shading by urban greenery, adequate tree distribution, the radius of influence and features of arboreal elements in the urban landscape in terms of thermal comfort improvement. Appropriate vegetation and adequate plant distribution used for shading in open areas can mitigate heat stress and increase human thermal comfort. Developing urban design guidelines based on tree shade is crucial to climate-resilient cities.

Atmospheric Pollution and Health

The need for general awareness, education and sensibilization of the public towards environmental problems (pollution, climate change) was highlighted in this session. The keynote was presented by Luis Fernando Amato-Lourenço (Institute of Advanced Studies, University of São Paulo, USP) and focused on the harmful impacts of microplastics on human health. Amato-Lourenço’s study identified microplastics (e.g. particles and fibers) in human lung tissue from the autopsy of non-smoking deceased patients that had spent at least 10 years in the megacity of São Paulo. In contrast, the autopsy of stillborns showed no signs of such elements in their lung samples. Marcelo Félix Alonso (UFPEL, Pelotas) showed that the Brazilian air quality network, founded in the 1960s, is still incipient, and it is critical to address maintenance problems from vandalism to ensure access to reliable air-quality data. Alfésio Braga (UNISANTOS, LPAE/FMUSP, FESP) highlighted the dosage issue in exposure to atmospheric pollution and its relationship with mortality and the pyramid of health effects related to pollution. Socio-economic status can lead to different health outcomes. The vulnerable strata of the population are more affected by pollution, from the fetus to the elderly, with acute and chronic effects ranging from asthma to cancer, with episodic symptoms or even leading to death. Solutions for reducing human risk and exposure to pollution encompass a massive control of the sources of pollution and urban planning with a focus on reducing exposure to pollutants. Public education and raising awareness of the health risks of pollution can also foster public policy interventions.

Climate Change

Central arguments displayed by the keynote speaker, Claudia Di Napoli (University of Reading, UK), were discussed in the round table that followed. Climate change research requires monitoring, risk analyses, valuable information to the public and, more importantly, action plans, resulting in a major change in human conscience and responsibility. Di Napoli presented the ‘Lancet Countdown: Tracking progress on health and climate change’ initiative, a

worldwide monitoring system able to track the multiple pathways in which climate change and weather extremes have affected human health since the 1980s. In the round table, Priscilla Teles (UNESP) showed data from IPCC – AR6 – WGII (Cissé et al., 2022), focusing on the vulnerability of different demographic groups to extreme climate and water scarcity. The various interactions with climate change pointed out by Di Napoli were addressed by Teles from the viewpoint of Brazil. Lincoln Muniz Alves (National Institute for Space Research / Instituto Nacional de Pesquisas Espaciais - INPE) tackled diverse aspects arising from climate change, such as implications of heat waves for health and the environment, the increasing risks in outdoor labor activities and the spread of vector-borne diseases induced by climate change in the country. The complexity of coping with climate change impacts on human health, quantifying associated risks, and establishing action plans is exemplified by AdaptaBrasil (<https://adaptabrasil.mcti.gov.br>). It is an online platform developed to consolidate, integrate, and disseminate vital information in a centralized and easily accessible manner spreading climate change awareness. Laurence Kalkstein (Arsht-Rockefeller Foundation Resilience Center, Arsht-Rock, U.S.A.) presented a heat warning system so stakeholders, policymakers and authorities can take action against upcoming heat waves. The system is currently being tested in cities in the U.S.A. and Europe. His talk also highlighted the importance of bringing combined health-climatological information to local government.

Climate, Health and Climate Change

On the last day of the symposium, research gaps and an open agenda on climate-related issues in the Brazilian context became more visible, offering an opportunity for the organizers to start planning. The broad scope of the addressed topics provided an overview of the area. It helped us identify some of the limitations of research conducted in Brazil on human biometeorology, as seen in the systematic literature review carried out by the organizers, that motivated organizing the symposium (Krüger et al., 2022).

Way forward

This summary discusses the meeting's main topics as a memento of the first Brazilian Symposium on Human Biometeorology. During the symposium in Natal, presenters and moderators frequently stressed the need for more studies to improve human biometeorological conditions in urban areas and 'climate-health hotspots' (Di Napoli et al., 2022). Possibilities and intentions of starting research collaboration were discussed, such as implementing novel heat wave warning systems in Brazil. The symposium was a further step beyond the systematic literature review conducted for Brazil by the event organizers toward a more consistent development and promotion of the country's broad area of human biometeorology. It is intended that a second symposium shall be organized soon on a biannual basis.

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