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BIOMETEOROLOGY AND ADAPTATION IN THE CONTEXT OF CLIMATE CHANGE AND BIODIVERSITY

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1. INTRODUCTION

In 1999, the International Society of Biometeorology (ISB) Congress was held in Sydney, Australia. This became an important event for many reasons, including the crafting of five Commissions in preparation for the 16th Congress in Kansas City.

The definition of Biometeorology is stated by the ISB (1996) as: "Biometeorology is an interdisciplinary science dealing with the application of fields of meteorology and climatology to biological systems. The general scope includes all kinds of interactions between atmospheric processes and living organisms - plants, animals and humans". Peter Hoppe's paper in the Congress Proceedings provided a valuable review of the past accomplishments and future directions for ISB and echoed the warm greetings of Professor G.O.P. Obasi when he stated that:

> " Both the International Congress (ISB) and the Conference (Urban Climatology) have long histories. The Congress had its first session in Paris in 1956, while the Conference on Urban Climatology date back to 1968 when WMO and the World Health Organization organized the first conference in Belgium. My very presence here today, and WMO's cosponsorship of the two events, are indicative of our commitment to the two subjects of biometeorology and urban climatology".

Several definitions of adaptation exist in the literature. "Adaptation" is commonly defined as the act or process of adapting and the state of being adapted. "Adapt" means to make more suitable, or to fit some purpose, by altering or modifying. The IPCC (Watson et al. 1996) defines "adaptability" as the "degree to which adjustments are possible in practices, processes, or structures of systems to projected or actual changes of climate; adaptation can be spontaneous or planned, and can be carried out in response to, or in anticipation of changes in conditions."

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Numerous examples of adaptive practices exist in the literature but little attention has focused on the biometeorological knowledge required to sustain populations under a significantly warmer global climate.

This Commission, unlike the others that evolved from previous study groups, is a **new** project requiring the building of new approaches, interactions, networks and funding. It has, as a scope, the integration of biometeorological adaptation science for climate change and biodiversity into international conventions, agreements and agencies. The fundamental relationship between the scientific fields of biometeorology and adaptation in the context of climate change and biodiversity are illustrated in the **framework development** established for this project.

This Commission has been design to initially investigate and improve the interlinkages and transfer functions between the many science sectors of biometeorology and the Convention on Climate Change and Biological Diversity using adaptation science as the portal.

The General Circulation Models have provided meteorological insights and scenarios of future impacts of climate change. Global biodiversity challenges are well documented and each issue provides an important platform to interact and link together the scientific findings from the many fields of biometeorology. For example, under the United Nations Framework Convention on Climate Change (UNFCCC), the Intergovernmental Panel on Climate Change (IPCC), in their third assessment, have identified a change in climate extremes that will, without a doubt, affect all segments of society. In turn, this will increase the need to develop biometeorological **transfer functions** and models. Increases in the heat index, fewer frost days, more frequent heat waves, more frequent summer droughts, and more frequent tropical cyclones are samples of the projected impacts of a changing climate, globally, nationally and regionally. Each sector of society will be affected and adaptation strategies, either re-active or pro-active are already

overdue in the context of climate change and biodiversity.

The Convention on Biological Diversity (CBD) was established along with the Subsidiary Body of Scientific, Technical and Technological Advice (SBSTTA) with the mandate to promote a wider assessment of the linkages between biological diversity and climate change. It is to prepare scientific advice to integrate biodiversity consideration into the implementation of measures to mitigate and adapt to climate change. In particular the interlinkages between climate change and biological diversity at SBSTTA6 were expanded to include:

- The impacts of climate change on biological diversity and the impacts of biological loss on climate change;
- The potential impact on biological diversity of mitigation measures that may be carried out under the United Nations Framework Convention on Climate Change and its Kyoto Protocol, and the identification of potential mitigation measures that also contribute to the conservation and sustainable use of biological diversity;
- The potential for the conservation and sustainable use of biological diversity to contribute to climate adaptation measures.

Canada and other countries were effective at broadening the emphasis on adaptation leading to the initiation of a pilot assessment by the CBD SBSTTA to prepare scientific advice to integrate biodiversity considerations into the implementation of the UNFCCC and its Kyoto Protocol. An ad hoc expert group was established to carry out this assessment, thereby opening the portal for the transfer of the results of this ISB Commission on biometeorological science.

In addition, convergence of three major efforts, biometeorological-based adaptation science, the network of UNESCO's World Biosphere Reserves and the Smithsonian Global Monitoring Network, may also provide some future directions for the International Society of Biometeorology. The establishment of Smithsonian Forest Monitoring sites (SI/MAB), monitored by community groups using the same protocols and standards worldwide (Dallmeier, 1992), is particularly unique and noteworthy. For example, using these global protocols for forest biodiversity monitoring, there are now more than 80 SI/MAB sites in Canada located across climate, chemical and ecological gradients. (MacIver, 1998). In addition, at the UNESCO/GTOS meeting in Rome, 2001, the network of more than 400 Biosphere Reserves plus the Smithsonian protocols and sites for measuring forest biodiversity at all taxa levels are now well-positioned to link together the human dimensions of development and natural conservation within an integrated abiotic, biotic, socio-economic and, more importantly, an adaptation framework. Once again, the portal was opened at the UNESCO/GTOS meeting in Rome to transfer the results of this ISB Commission on biometeorological science and adaptation.

As a starting platform, this Commission embarked on a **literature assessment** of the potential research linking ISB biometeorological research with adaptation in the context of climate change and biodiversity. Limited funding was provided by Environment Canada for the establishment of this project which is expected to grow with the collection of scientific knowledge that could be transferred and implemented globally. Thus, we invite authors to contribute relevant published material. We envision that the work here will be eventually used in many international science assessments.

In addition, the **Integrated Mapping Assessment Project (IMAP)** - a pilot country-type project was also developed by Environment Canada for this Commission. This project is a methodology designed to assess multiple issues within numerous geographical scales - a tool for decision-makers and policy developers. The guidelines for country-based IMAP studies will be discussed in a separate paper in this Congress (Auld et al.).

2. Framework Development

The framework should be viewed as a cascading matrix where all three organizations (UNFCCC, CBD and ISB) are interlinked to each other. Atmospheric sciences are the basis of biometeorological transfer functions for adaptation. Within the detailed matrix structure, the atmospheric sciences under consideration are grouped in the following categories: general meteorology; thermal physiology, comfort and stress; weather and climate; knowledge of physical and chemical processes; remote sensing; knowledge of airflows and turbulent transfers; micro-meteorology; and the integration of atmospheric processes. The biometeorological transfer functions found in each of these adaptation categories are: agriculture; forestry; biodiversity; human health; animal health; energy & transportation; infrastructure; community settlement; and urban.

	UNFCCC – IPCC	CBD - SBSTTA
ISB	Science-Policy Interlinkages at the Congress/Convention levels	

		UNFCCC – IPCC	CBD - SBSTTA
		ADAPTATION	
ISB	Atmos. Science	**Adaptation Science Interlinkages**: e.g. Meteorology, Climate, Hydrology and Air Quality, Medical and Aerobiology Research…	

3. Transfer Functions

In Commission 4, adaptation transfer functions have been derived mainly from three sources of published information for the period of 1963 to the present. Our sources include:

- The Congress Proceedings of the International Society of Biometeorology (ISB) held every 3 years.
- The International Journal of Biometeorology (IJB); and
- The climate change assessments of the United Nations Framework Convention on Climate Change (UNFCCC), more specifically the International Panel on Climate Change (IPCC).

The study objectives were:

- to determine the number of biometeorological articles dealing with adaptation on the impacts of climate change and variability, as well as adaptation and biodiversity
- to summarize, in an annotated format, particularly those articles that contain transfer functions.
- to create a resource base of biometeorological information on CD-ROMs and the WEB, as a portal for use by the UNFCCC, CBD and UNESCO/GTOS and other agencies.

The number of authors reviewed is summarized in the following table. The ISB Proceedings and the IJB reviews went back to 1963, while all three IPCC reports, dating back to 1990, were reviewed.

Name	ISB	IJB	IPCC
Appears	Total Papers (1269)	Total Papers (615)	Total Papers (488)
=> 6	2	2	0
= 5	11	2	1
= 4	11	12	7
= 3	48	31	29
= 2	166	92	71

The ISB Congress Proceedings contain the largest number of authors. The **Adaptation Matrix** on the CD-ROM, for example, lists the authors that are relevant to the present study. It is evident that the number of articles specifically containing transfer functions for adaptation to climate change and biodiversity are few (ISB = 44, IJB = 31, IPCC = 12). The section containing the greatest number of adaptation transfer functions is human health. Sections with fewer adaptation transfer functions are: infrastructure, biodiversity, energy & transportation, and community settlements. Significant opportunities for biometeorological research are warranted, given that the adaptation portals have been established with a number of international conventions and agencies.

The work of this Commission is still in progress and authors are encouraged to forward their articles for appropriate reference and insertion into the WEB-based and CD-ROM adaptation matrix on climate change and biodiversity. Brief annotated summaries, including relevant graphics, are available by simply electronically highlighting the authors name within the matrix. It is intended that this resource will improve the connectivity of ISB research efforts within the context of climate change and biodiversity, as a first step.

4. References

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