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Urban Man & Climate in Buildings

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ABSTRACT

Urban climate conditions affect cities will develop in the future, not only because of the impact on the environment or on the energy consumption of buildings, but also on outdoor human comfort. The configuration of buildings is one of the main factors that influence the different microclimates in the city. Understanding and especially being able to predict and manipulate these urban microclimates improve different aspects of urban life including the outdoor thermal comfort. Because of this, it is possible to use indices of outdoor thermal conform to understand and the configurations of building affect the microclimate conditions. This paper describes a method that enables the integration of microclimate data into the creation of new urban forms using outdoor thermal comfort as an indicator and translates this knowledge into a parameterized design-feedback tool. In this way, it will be possible to support the design process by automated tools that explore design spaces of urban forms according to measurements and empirical findings on the relationship between microclimate data and the building geometries.

KEYWORDS: *Human, Climate, Environment, Earth, Sky, Sun, Wind, Water*

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INTRODUCTION

The world is facing unprecedented speeds in climate-change leading to an increase in global average temperatures, commonly referred to as global warming. Cities are seen not only as potential sites of climate vulnerability but also as the main contributor. Urban areas absorb and retain significantly more heat than rural areas. This warmth of cities in contrast to their surrounding is known as Urban Heat Island. One of the most important factors affecting the intensity of the UHI is the configuration of buildings; moreover, the situation differs according to the local climate. As suggested by the 'United Nations Environment Program, cities need to adapt to future urban climates. Understanding and especially being able to predict and manipulate urban microclimates may help improve aspects on pedestrian activity in urban spaces, and on the performance of buildings, especially in respect to energy conservation.

Climate change is making extreme heat events worse and more frequent, with summer temperatures stretching into the shoulder seasons of spring and fall. Heat events adversely affect health and quality of life—and this is especially acute in urban communities. Higher cooling demand strains the electric grid and raises electric bills. And heat-related impacts fall unequally, with historically underserved populations facing greater health threats.

Urban planning and urban design have a critical role to play in the global response to climate change. Actions that simultaneously reduce greenhouse gas emissions and build resilience to climate risks should be prioritized at all urban scales – metropolitan region, city, district/neighborhood, block, and building. This needs to be done in ways that are responsive to and appropriate for local conditions.

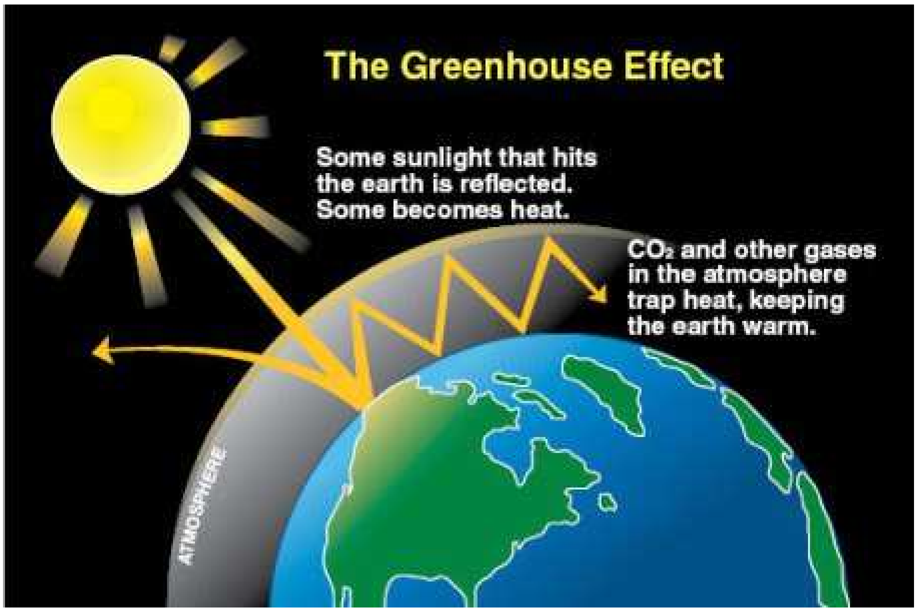

Fig.1 Green House Effect

Integrated climate change mitigation and adaptation strategies should form a core element in urban planning and urban design, taking into account local conditions. This is because decisions on urban form have long-term (>50 years) consequences and thus strongly affect a city's capacity to reduce emissions and to respond to climate hazards over time. Investing in mitigation strategies that yield concurrent adaptation benefits should be prioritized in order to achieve the transformations necessary to respond effectively to climate change.

Thermal comfort:
Outdoor spaces are important for cities as these provide daily pedestrian traffic and different outdoor activities contributing to urban livability and vitality. Promoting the use of streets and outdoor spaces by pedestrians will benefit cities from physical, environmental, economical, and social aspects. In this way, ensuring that people are comfortable in outdoor spaces is essential to a better quality of urban life. Over the past few decades, making outdoor spaces attractive to people, and ultimately used by them, has been increasingly recognized as a goal in urban planning and design. Among many factors that determine the quality of outdoor spaces, the urban microclimate is an important one. Pedestrians are directly exposed to their immediate environment in terms of variations of air temperature, relative humidity, wind speed, and solar radiation. Therefore, people's sensation of thermal comfort is greatly affected by the local microclimate.

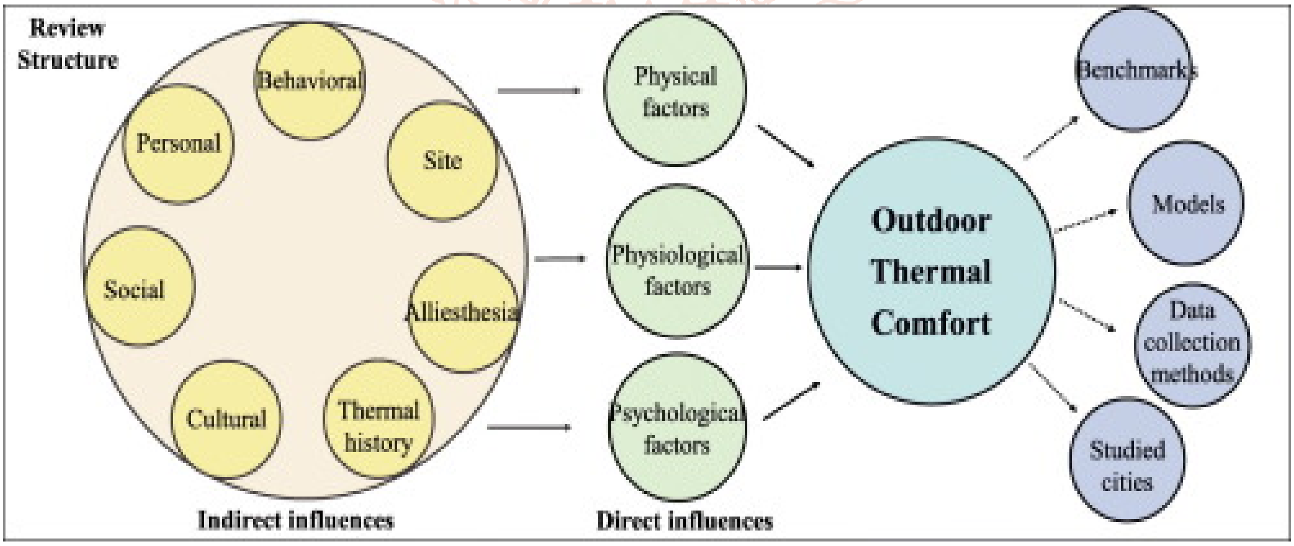

Fig.2 Thermal factors

Simulation in city Planning and Design:
There is a growing tendency on finding how our understanding of the urban microclimate may be applied in practice for urban planning and design. This is not an easy task as trying to respond to different criteria of urban microclimate might lead to contradictory requirements. However, microclimate has an effect on a very broad range of issues encompassed in the field of urban planning and design. The different effects of urban microclimate in urban planning and design can be divided into two groups; the effect of microclimate on the

performance of buildings, especially in respect to energy conservation and the effect of microclimate on human activity, specially pedestrian, in the spaces between building.

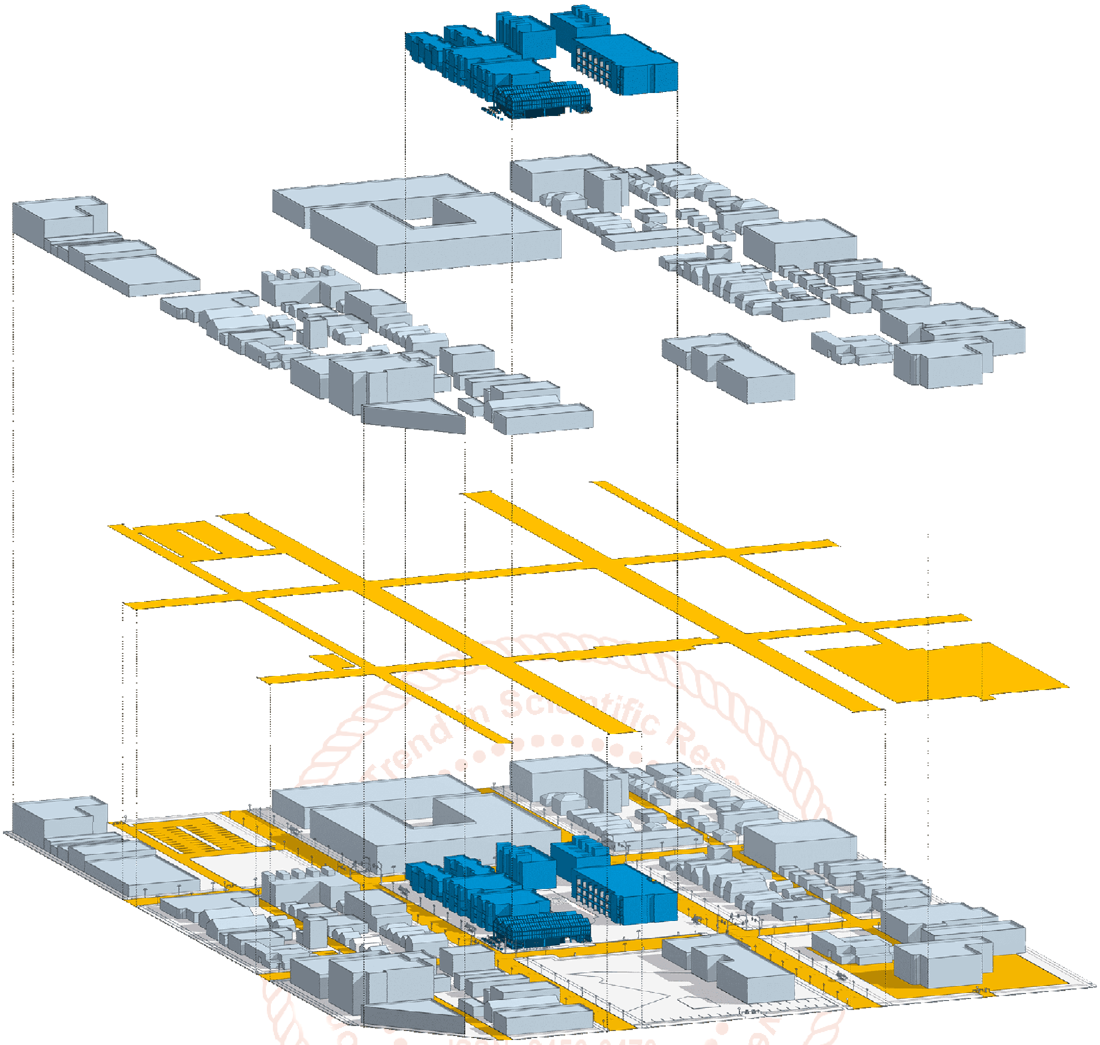

Fig.3 Simulation of planning

Generative systems in design and planning:

It is useful to consider architectural design as a particular type of problem-solving process in order to discuss design within the framework of a general theory of problem-solving. In problem-solving if the goal is to arrive to something that does not yet exist, it is possible to construct a generative system, which can then be operated to produce a variety of potential solutions. In this context, Aristotle argued that, in a similar way, designs for potential cities could be generated by analyzing cities into their essential constituent parts, listing the alternatives for each part, and then taking various different combinations of alternatives. Generative systems have played important roles in the development of engineering and architectural design methodology. In architecture, these methods are based upon systematic exploration of alternative ways in which various elements from a fixed vocabulary could be assembled in different combinations to generate architectural forms. This systematic use of generative systems in architectural design can also be applied in urban design and planning as Aristotle ones proposed.

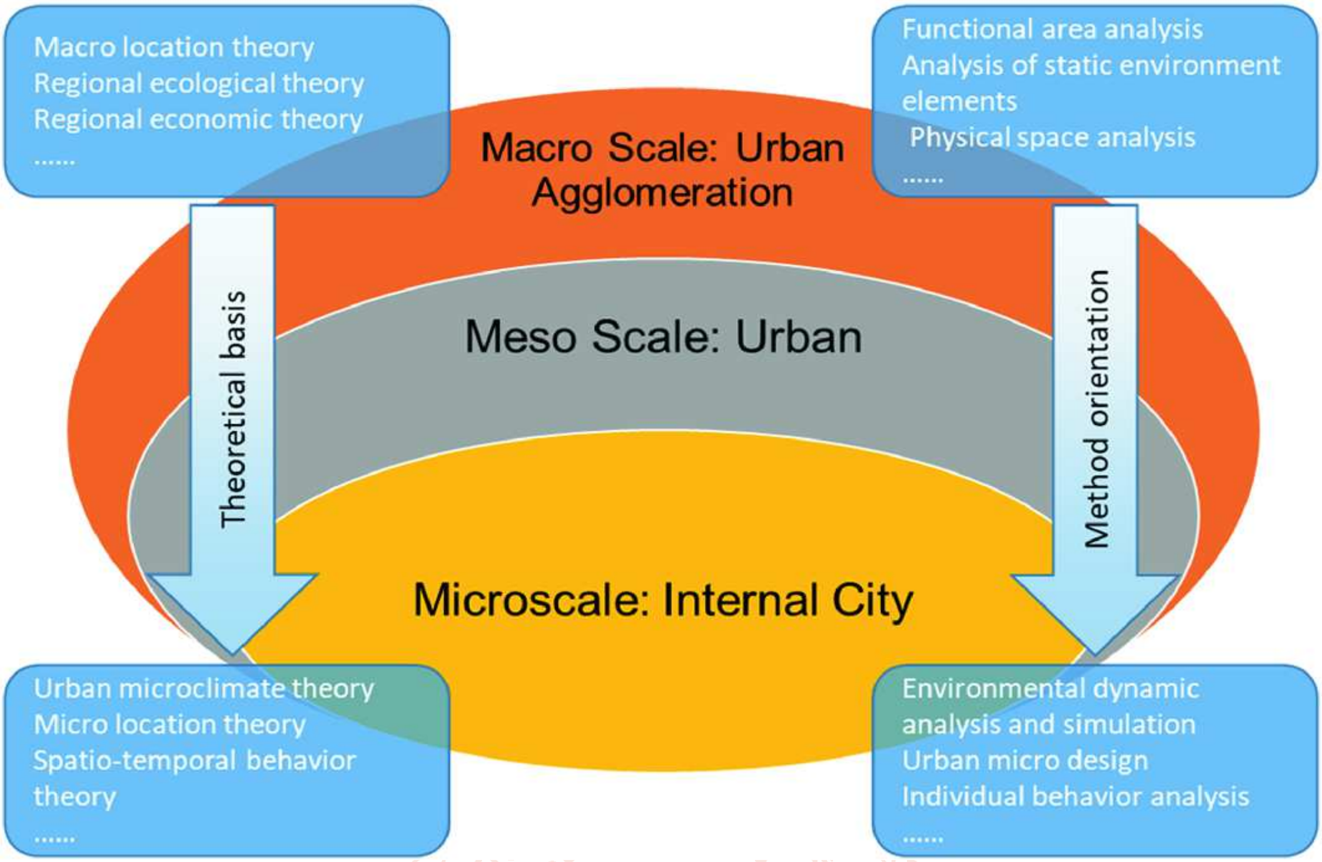

Fig.4 Planning Scale

Transportation, Energy, and Density:

Since the middle of the 20th century, built environments the world over have tended to increase outward from central cities, consuming great swaths of previously undeveloped land while reinvestment in city centers falters. The infrastructure network needed to maintain this sprawling development pattern, particularly roads, has resulted in development that is land and infrastructure inefficient. It has also led to increased reliance on motor vehicles to get from one place to another. This reliance on motor vehicles has consequently led to a significant increase in vehicle miles (or kilometers) traveled, a concomitant increase in GHG emissions, and an amplification of the UHI effect through increased imperviousness, reduced green cover, and enhanced waste heat emissions. By developing in a denser, more compact form that mixes land use and supports mass transit use, cities may begin to reverse these trends.

Fig.5 Energy Frame

Green and Blue Infrastructure:

The interaction of green and blue components in the urban environment links together integrated mitigation and adaptation strategies at different scales – from buildings and open spaces design to landscape design and metropolitan region planning – and can yield many co-benefits. A comprehensive climate-based design supports developing and maintaining a network of green and blue infrastructure integrated with the built environment to conserve ecosystem functions and provide associated benefits to human populations. Urban planning and urban design strategies focusing on green infrastructure and sustainable water management help restore interactions between built and ecological environments. This is necessary to improve the resilience of urban systems, reduce the vulnerability of socioeconomic systems, and preserve biodiversity.

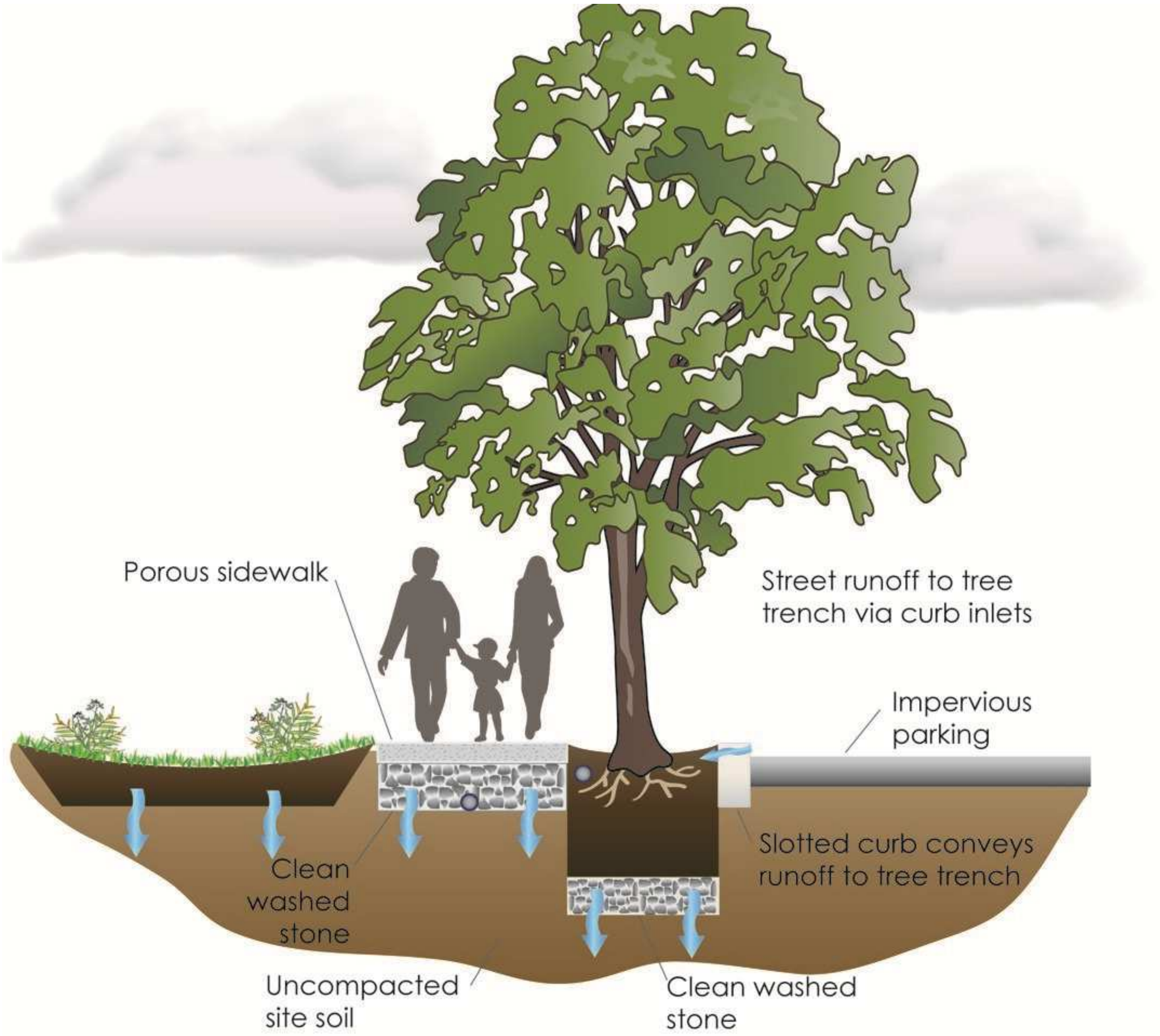

Fig.6 Green and Blue Infrastructure

Climate Analysis and Mapping:

Considering climate in urban planning and urban design, the first step is to understand large-scale climatic conditions and individual inner-city local climates, including their reciprocal interactions

- Regional occurrence and frequency of air masses exchange (ventilation) and their frequencies;
- Seasonal occurrence of the thermal and air quality effects of urban climate (stress areas, insolation rates, shading conditions);
- Regional presentation and evaluation of the impact area and stress areas; and
- Energy optimization of location based on urban climate analysis with regard to areas with heat load, cooler air areas, and building density.

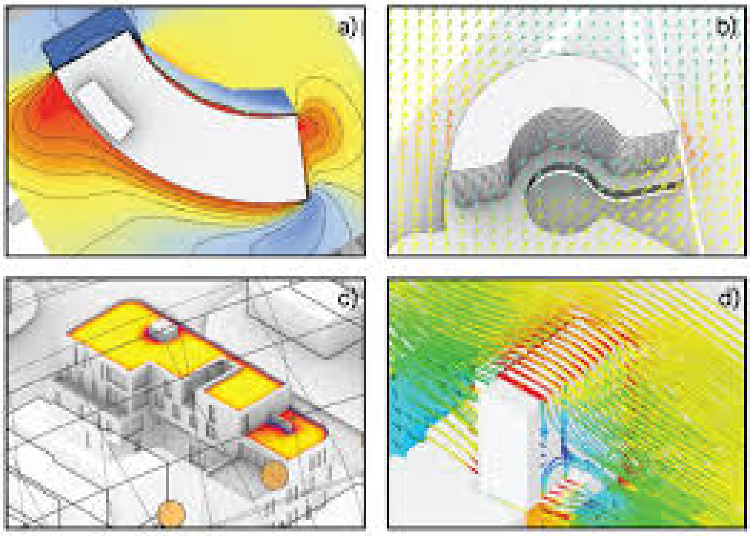

Fig.7 Climate Analysis

Climate:

Climate is the long-term pattern of weather in an area, typically averaged over a period of 30 years. More rigorously, it is the mean and variability of meteorological variables over a time spanning from months to millions of years. Some of the meteorological variables that are commonly measured are temperature, humidity, atmospheric pressure, wind, and precipitation. In a broader sense, climate is the state of the components of the climate system, which includes the ocean, land, and ice on Earth. The climate of a location is affected by its latitude/longitude, terrain, and altitude, as well as nearby water bodies and their currents.

Climates can be classified according to the average and the typical ranges of different variables, most commonly temperature and precipitation. The most commonly used classification scheme was the climate classification. The system in use incorporates evapotranspiration along with temperature and precipitation information and is used in studying biological diversity and how climate change affects it. The Bergeron and Spatial Synoptic Classification systems focus on the origin of air masses that define the climate of a region.

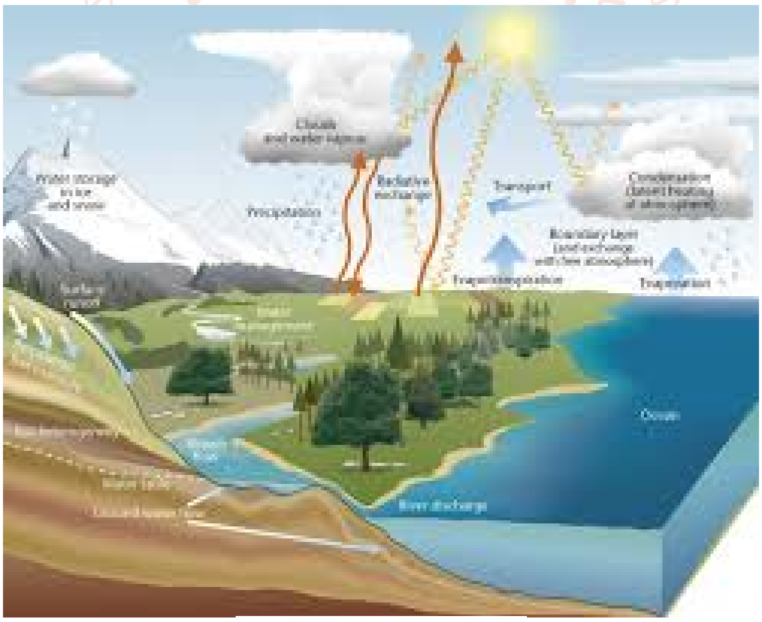

Fig.8 Climate System

Environment:

Natural world encompasses all living and non-living things occurring naturally, meaning in this case not artificial. The term is most often applied to the Earth or some parts of Earth. This environment encompasses the interaction of all living species, climate, weather and natural resources that affect human survival and economic activity the concept of the *natural* environment can be distinguished as components:

- Complete ecological units that function as natural systems without massive civilized human intervention, including all vegetation, microorganisms, soil, rocks, atmosphere, and natural phenomena that occur within their boundaries and their nature.

- Universal natural resources and physical phenomena that lack clear-cut boundaries, such as air, water, and climate, as well as energy, radiation, electric charge, and magnetism, not originating from civilized human actions.

Fig.9 Environmental Effect

Sector Linkages:

There is a growing consensus around integrating urban planning and urban design, climate science, and policy to bring about desirable microclimates within compact, pedestrian-friendly built environments. However, there remains much work to do to bridge the gaps in tools, methods, and language between the scientific, design, and policy-making communities. Conveying a compelling investment/payback narrative also remains a challenge for setting priorities with stakeholder groups. Ad hoc, disconnected approaches fail to exploit synergies between professional practitioners, and departments within government administrations are often insufficiently coordinated to capitalize on cross-disciplinary actions. Silos of expertise are difficult to harness over the long-term due to different departmental missions. A central challenge remains the poor interdisciplinary connections between the various policy experts, technical specialists, and urban planners/urban designers. The absence of objective evaluation methodologies in the practice of climate-resilient urban design illustrates this divergence, as does the lack of a common interdisciplinary methodology for addressing various spatial scales. For example, urban climatology research produces sophisticated but theoretical results that resist easy integration with empirical, design-oriented findings of urban design.

CONCLUSION-

The main outcome of this method is an automated tool to explore design spaces of urban forms according to measurements and empirical findings on the relationship between the outdoor thermal comfort, the microclimate conditions and the building geometries. This generative method will systematically translate urban climate data into design variants. In this way, this process will contribute to urban planning practices as a decision-support tool to provide guidelines for the construction of climate-sensitive urban forms. The reduction of energy consumption of buildings can be a side contribution. Although the calculation has been implemented in various different locations, it has been barely used in extreme climates such as the tropics. In these climates, the outdoor thermal comfort is one of the main parameters evaluated for the quality of urban life. This human comfort in the open spaces affects the pedestrian activities altering the live-ability of the urban area.

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