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On the Estimation of Building Components' Exposure to Moisture in Greece using Climatic Data of different Time Resolution

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Abstract

In this paper the effect of using climatic data of different time resolution on parameters related to building components' exposure to moisture at 39 locations in Greece is investigated. Moisture indices are calculated for each site using average daily, monthly and annual climatic data (both the drying and the wetting potential are considered), and are used for the ranking of the investigated sites regarding building components' moisture loading. The results produced for the relative exposure to moisture, the drying and the wetting potential at the examined sites with the use of data of different time resolution are compared and discussed.

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Keywords: moisture index; drying; wetting; driving rain; exposure to moisture

1. Introduction

In the context of a holistic approach to the implementation of sustainability principles in the building sector, issues related to service life of buildings and building components must be addressed. Hence, factors associated with the durability of materials and components, as well as to the loadings (climatic, chemical, etc.) that are related to frequently occurring and important degradation mechanisms and deterioration processes should be taken into consideration. The presence, accumulation and periodic – or not – variations of moisture inside and on the surface of building components have been identified as being among the determining factors for the occurrence and/or

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acceleration of several building materials' and components' deterioration mechanisms – physical, chemical and biological – and types (e.g. mould formation, frost attack, steel corrosion, increase of materials' thermal conductivity, etc.). As a result, moisture in building components (in its various phases: water, vapor and ice) affects both safety and functionality aspects of the building's performance and is closely related to the maintenance and replacement requirements that will emerge during the building's service life. The afore-mentioned maintenance and replacement requirements are also tightly connected to several aspects of the building's economic performance; furthermore, moisture in buildings components has been correlated with health problems (e.g. respiratory symptoms) in building occupants[1,2] and, therefore, could be correlated with the quality of the indoor environment provided by the building. As a result, building components' hygrothermal performance, as well as their exposure to moisture loadings, are issues of noteworthy importance in the context of buildings environmental performance assessment studies. Therefore, the existence of simple tools and metrics for the estimation of building components' exposure to moisture at a location can be of great practical importance. Several indices have been proposed and used for the estimation of the exposure of building components to moisture from various sources; e.g., the calculation of driving rain indices[3] has been employed for the assessment of the exposure of vertical building components to driving rain.

In this paper, the relative exposure of building components to moisture at various locations is expressed with the use of a moisture index presented in previous studies[4,5]. With this index, in the calculation of which not only the wetting, but also the drying potential at a site are taken into consideration via the use of a wetting and a drying index respectively, the exposure of building components to moisture at various sites can be compared. The focus of the study presented in this paper is on the effect of using climatic data of different time resolution on the calculated moisture indices at 39 sites in Greece. Specifically, these indices are calculated for 39 sites spatially distributed all over Greece on the basis of average daily climatic data and of the – derived from the previously mentioned daily data – average annual and average monthly values of the related climatic parameters. The average daily (air temperature and relative humidity, wind speed and precipitation) data have been provided by the Hellenic National Meteorological Service (H.N.M.S.) for every day of a period extending to several years for each site. The images produced for the relative exposure to moisture, as well as the drying and wetting potential, at the examined sites with the use of data of different time resolution are compared, the possible sources of discrepancies are discussed, the results are analysed and conclusions are drawn.

2. Investigation of the effect of using average daily, monthly and annual climatic data on the estimated relative exposure to moisture at several sites in Greece

2.1. Mathematical formulations and climatic data

The calculation of the moisture index used in this study is based on the combination of a wetting index (*WI*) and a drying index (*DI*)[4,5]. This way, the acquired estimation expresses both the wetting and the drying potential of a building component at a site; this consideration is rather important for building components' hygrothermal performance since it is not only the moisture load that determines the moisture "strain" on a component; issues such as the succession of wetting and drying cycles, the quicker or slower drying of a wetted component and others can be of crucial importance. The drying index at a site is calculated on the basis of the following equation, with the use of hourly climatic data for this site[4,5]:

$$\Delta w(T) = w_{sat}(T) - w_{out}(T) = 0.622 \times \frac{p_{sat}(T)}{P_{atm} - p_{sat}(T)} - 0.622 \times \frac{RH \times p_{sat}(T)}{P_{atm} - RH \times p_{sat}(T)} \quad (1)$$

in which T (ºC) is the hourly air temperature, RH (-) is the hourly ambient air relative humidity, $psat$ (Pa) is the water vapor saturation pressure at given temperature, $Patm$ (Pa) is the total atmospheric pressure (considered to be equal to 101325Pa) and $wj(T)$ (kg water/ kg air) is the humidity ratio at a given temperature. The hourly values of $\Delta w(T)$ calculated for all the hours of a year are summed to provide the DI of this year for the site under study; then, the average of the yearly values of DI that are derived for several years is used as the DI of the site[4,5].