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EVALUATION OF THE ENERGY IMPACT OF GREEN AREA SURFACES AND VEGETATION COVER IN FORESTED URBAN ENVIRONMENTS WITH DRY CLIMATES. CASE: MENDOZA METROPOLITAN AREA, ARGENTINA.

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Abstract

The object of this work is to study the energy impact caused by green surface area and vegetation coverage present in the low-density urban environment in the metropolitan area of Mendoza (AMM), Argentina, in order to understand the morphology of forested city in an arid climate, and, in the future, to determine the potential real modification on those urban microclimate environments essentially dependent on energy exchanges.
Methodologically on the urban green space level, the green surface and the different mineralized surfaces have been quantified from surveyed land data, aerial photographs, and by an accompanying representative in-situ survey of 32 city blocks in the AMM. In addition, using the i-tree canopy tool, the urban area covered by tree vegetation mass or vegetation cover has been quantified. Subsequently, using ecophysiological coefficients[1], an environmental index for each environment analyzed has been determined, indicating the percentage of the total area of green space environmentally useful as an environmental modifier.
The results obtained indicate mean values of green surface (herbaceous grass) of 22.83% in the urban environments analyzed (20.22% public and private), plus a 2.62% non-mineralized surface devoid of vegetation cover (permeable irrigation channel). The results using the i-tree tool indicate an urban surface covered by a vegetation tree mass of 26.59%, and a total of 41.08% non-mineralized surface, including trees, grass lawns, bushes and bare ground. In terms of environmental indices, values were established for the 32 environments analyzed, from a mean of 0.46, with the highest indices of 0.59 through the positive effect of vegetation cover from the thermodynamic point of view,

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and, on the other hand, with minimum indices of 0.39 in environments with a low percentage of urban trees and a high quantity of mineralized surface directly exposed to solar radiation.
As a result of such a process, it is possible to determine current conditions and the formulation of an environmental diagnosis based on vegetation cover, adapted to consolidated environments of low density in a model of a forested city in arid climate, and it is hoped that this work presents the possibility of evaluating the energy impact of vegetation cover to implement future norms and rules aimed both at preserving the forested city model, in equilibrium with a model of the sustainable city, and at reversing urban-building growth that does not take such factual indicators into consideration.

Keywords: *sustainable urban development; green area surfaces; vegetation cover; forested urban environments.*

Nomenclature

A	area [m^2]
c	coefficient of adjustment to calculate actual evapotranspiration when cultivated under tree cover
ea	actual vapour pressure [kPa]
es	saturation vapour pressure [kPa]
es-ea	saturation vapour pressure deficit [kPa]
ETo	reference evapotranspiration [mm day^{-1}]
Ea	actual evapotranspiration
SOF	soil occupation factor
TOF	total occupation factor
G	density of heat flux on the ground [MJ m^{-2} day^{-1}]
EI	environmental index
IGSA	índex of green surface area
IVC	índex of vegetation cover
Kc	single crop coefficient of cultivation, índex of adjustment
Nt	number of theoretical sunlight hours
Na	number of actual sunlight hours
QL	latent heat fluxes
Qs	sensitive heat fluxes
Qt	storage net uptake, or release of energy by sensitive heat changes in the urban ground-canopy-air volume
R	stratospheric solar radiation, expressed in equivalent evaporation (mm/day)
RN	solar radiation absorbed by the surfaces
Rn	net radiation at the crop surface [MJ m^{-2} day^{-1}]
Ro	solar radiation incident in location
T	mean daily air temperature at 2 m height [°C]
y	latitude of location
γ	psychrometric constant [kPa $°C^{-1}$]
Δ	slope vapor pressure curve [kPa $°C^{-1}$]
μ2	wind velocity registered at 2 m of height [m s^{-1}]
α	albedo of considered surface
$1-\alpha$	percentage of the proportion of solar radiation solar that is absorbed
Q	all-wave radiation flux/ net radiation
*Q*S	storage net uptake, or release of energy by sensitive heat changes in the urban ground-canopy-air volume
ΔQA	advective heat flux
*Q*F	anthropogenic heat flux from heat released by combustion of fuels (e.g., traffic, building HVAC systems)
*Q*H	sensitive heat fluxes
*Q*E	latent heat fluxes
Q*	the net all-wave radiation flux/ net radiation
K	short-wave (from the sun) radiation flux, arrows indicate the flow of energy is toward (↓)or(↑) from the surface
L	long-wave (or terrestrial) radiation flux, arrows indicate the flow of energy is toward (↓)or(↑) from the surface

1. Introduction

The constant growth that will exponentially increase world population[2,3]consumption of non-renewable resources, pollution, and rates of urbanization3 in developing countries, becomes particularly critical in urban areas, and