Advanced Materials Research Vols. 734-737 (2013) pp 1865-1869
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doi:10.4028/www.scientific.net/AMR.734-737.1865

Assessment of the Trend of Albedo: a Case Study of Palermo

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Keywords: global warming; albedo; solar radiation; bioengineering.

Abstract. In this paper we propose a case study of urban heat island applied to Palermo. The urban heat island (UHI) is the most studied of the climate effects of settlements. The UHI refers to the generally warm urban temperatures compared to those over surrounding, non-urban, areas. The aim of this paper is to find a connection among the average rise in temperature and the modification of albedo.

Introduction

The likelihood that continuing greenhouse-gas emissions will lead to an unmanageable degree of climate change has stimulated the search for planetary-scale technological solutions for reducing global warming[1], typically characterized by the necessity for costly new infrastructures and industries. We suggest that the existing global infrastructure associated with arable agriculture can help, given that crop plants exert an important influence over the climatic energy budget because of differences in their albedo (solar reflectivity) compared to soils and to natural vegetation.
An other important aspect is the knowledge of the urban heat island.
The urban heat island (UHI) is the most studied of the climate effects of settlements. The UHI refers to the generally warm urban temperatures compared to those over surrounding, non-urban, areas. It is important, however, to distinguish between the 'types' of UHI (for example, one defined by surface or air temperatures) as the observations and responsible processes will differ. The UHI is typically presented as a temperature difference between the air within the UCL and that measured in a rural area outside the settlement (ΔT_{u-r}). In this paper is proposed an analysis of albedo and the parameters that influence it.[2]

It represents a ration among reflected and incident radiation. It' s a function of different variables as cloudiness; presence of vegetation and angle of incidence of solar radiation.[3-4]

Surface broadband albedos are not the sole measures of surface reflective properties since they also depend on the atmospheric conditions. The downward flux distribution at the bottom of the atmosphere is the weighting function for converting spectral albedos to broadband albedos, and different atmospheric conditions have different downward flux distributions. Thus, surface broadband albedos retrieved under one specific atmospheric condition from remotely sensed data may not be applicable to other atmospheric conditions. [5-8]

Methods.

To evaluate the estimate of albedo were used the images taken by satellite LANDSAT.
The images represent:

- an urbanized area within the city of Palermo;
- a vegetation area below the slopes of "Monte Pellegrino".

The second step is georeferencing of the image that is geometrically correct and conforms to a fixed reference system such as UTM ED50 in each case.

The last step is to atmospheric correction, namely the elimination of scattering effect of the atmospheric layer interposed between the sensor and the surface [9-12].

All these operations were carried out through the 'use of the analysis software and digital image processing ENVI. In the table 1-2 we find the value obtained.[13]

Table 1. Values of Albedo of urbanized area

DATA	MINIMO	MASSIMO	MEDIA	DEV.STAND
2005_11_12	0,033381	0,12626	0,079005	0,012802
2005_07_07	0,062677	0,174211	0,109724	0,015106
2005_03_17	0,046751	0,13996	0,083236	0,012369
2004_10_24	0,043569	0,132711	0,078703	0,01181
2004_07_20	0,062742	0,152711	0,099421	0,013601
2004_04_15	0,049759	0,136022	0,090642	0,01135
2003_01_15	0,031835	0,148001	0,085944	0,015038
2002_10_27	0,032143	0,178122	0,100795	0,017959
2002_07_07	0,077527	0,170751	0,114497	0,012525
2002_02_13	0,035013	0,179566	0,096932	0,016655
2001_10_08	0,058146	0,154389	0,094606	0,012215
2001_01_25	0,040407	0,167201	0,092589	0,0215
2000_10_21	0,047759	0,183581	0,099543	0,016158
2000_07_25	0,065367	0,127684	0,088542	0,008603
2000_07_01	0,08276	0,225043	0,12579	0,016719
2000_03_03	0,034915	0,140595	0,076352	0,012333
2000_01_31	0,029367	0,113385	0,069166	0,011407
1999_11_20	0,050014	0,150504	0,091927	0,014372
1999_10_11	0,033809	0,15872	0,082171	0,014102
1999_07_23	0,054537	0,149584	0,090222	0,012552
1999_03_01	0,030056	0,149224	0,075235	0,012775
1999_01_12	0,026594	0,130917	0,068153	0,012467
1998_11_09	0,032934	0,139807	0,076588	0,013337
1998_07_20	0,046412	0,17446	0,095022	0,014119
1998_04_15	0,057977	0,172098	0,085644	0,01071
1998_01_09	0,027047	0,144924	0,068269	0,012664
1997_10_05	0,059675	0,160954	0,096026	0,011291
1997_07_01	0,056922	0,182744	0,106317	0,014842
1997_05_14	0,057439	0,158234	0,094916	0,011985

Table 2. Values of Albedo of vegetation area

DATA	MINIMO	MASSIMO	MEDIA	DEV. STAND
2005_11_12	0,043132	0,090766	0,067358	0,012524
2005_07_07	0,067899	0,112822	0,094404	0,01098
2005_03_17	0,046796	0,084909	0,066524	0,010871
2004_10_24	0,043393	0,07725	0,061078	0,008921
2004_07_20	0,059445	0,092821	0,076224	0,007387
2004_04_15	0,050096	0,088653	0,071784	0,010412
2003_01_15	0,04268	0,089471	0,06824	0,012391
2002_10_27	0,054133	0,104529	0,084507	0,013158
2002_07_07	0,078782	0,151516	0,108935	0,013587
2002_02_13	0,050139	0,098692	0,076876	0,01166
2001_10_08	0,052423	0,099524	0,079906	0,011389

2001_01_25	0,060444	0,120161	0,090646	0,01556
2000_10_21	0,051396	0,104384	0,080481	0,013107
2000_07_25	0,062001	0,095971	0,081441	0,008974
2000_07_01	0,070273	0,124774	0,104429	0,012855
2000_03_03	0,04257	0,087118	0,070256	0,010946
2000_01_31	0,037516	0,083499	0,059819	0,012216
1999_11_20	0,101684	0,188691	0,13727	0,022704
1999_10_11	0,046061	0,090802	0,0711	0,011303
1999_07_23	0,063698	0,108792	0,091014	0,011749
1999_03_01	0,043981	0,085134	0,068338	0,010582
1999_01_12	0,037414	0,086584	0,062572	0,013083
1998_11_09	0,041407	0,094842	0,069091	0,013436
1998_07_20	0,065866	0,106759	0,089899	0,010242
1998_04_15	0,054247	0,085305	0,071988	0,008515
1998_01_09	0,039933	0,080275	0,061008	0,011212
1997_10_05	0,059029	0,104708	0,081345	0,011662
1997_07_01	0,076839	0,132682	0,110148	0,014037
1997_05_14	0,060706	0,098715	0,083858	0,009478

We used algorithm of Liang [2] to revise the values:

$$\alpha_{short} = 0.35\alpha_1 + 0.130\alpha_3 + 0.373\alpha_4 + 0.085\alpha_5 + 0.072\alpha_7 - 0.0018 \tag{1}$$

The mean value of albedo of urbanized area ist the average of the maximum values, while the mean value of vegetation area is the average of mean values. So the values are 0.156 and 0.0807.

Case Study.

The calculation of the evolution of the albedo of Palermo is made as weighted average:

$$A_{Palermo} = \frac{A_{urban}(t)}{A_{total}} \bullet \alpha_{urban} + \frac{A_{veget}(t)}{A_{total}} \bullet \alpha_{veget} \tag{2}$$

where α_{urban} is 0.156 an α_{veget} is 0.0807 and $A_{urban}(t)$ and $A_{veget}(t)$ are numbers that change in the chosen time.

In particular, these values that are function of time and total area sample were calculated using old plan oft he city an GIS. In table 2 we report these values

Table 2. Evolution of area of Palermo

PERIOD	AREA VEGET [m^2]	AREA URBAN [m^2]	Area total [m^2]
1860	90182537,49	2687957,15	92870494,64
1921	69871170,85	22999323,79	92870494,64
1975	61965704,34	30904790,30	92870494,64
2005	14455825,21	78414669,43	92870494,64

The results are showed below.

Table3. Average trend Albedo of Palermo

DATE	AREA VEGETA	AREA URBAN	Area total	A_{urban}/A_{total}	A_{vegeta}/A_{total}	Albedo
1860	90182537,49	2687957,15	92870494,64	0,03	0,97	0,083
1921	69871170,85	22999323,79	92870494,64	0,25	0,75	0,099
1975	61965704,34	30904790,30	92870494,64	0,33	0,67	0,106
2005	14455825,21	78414669,43	92870494,64	0,84	0,16	0,144

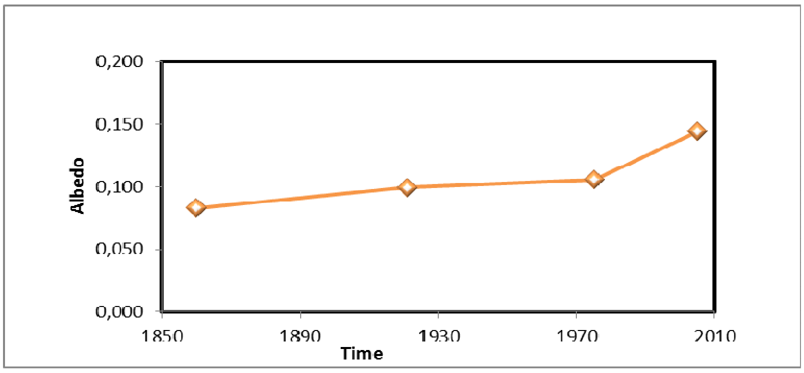

Figure 1. Average trend of Palermo

Conclusion.

The obtained results show a growth of value of albedo (an increas of urbanized area)[14].This modification causes an increase of mean temperature of the zone under this study. We assist a total change of natural energy balance of the palanet. The aim of this work is to encourage the governments of major cities to controlthe urbanization of the city.

Acknowledgment.

This work was funded by Ministero dell‘ Ambiente e Del Mare through IMPETUS project.

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