Study on Surface Albedo of Different Land Cover Types in Liaoning Province

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Abstract— Using MODIS image, we analyzed the relationship between surface albedo and underlying surface in Liaoning Province. In this paper, we not only compared the magnitude of albedos of different surface coverage types in Liaoning, we also analyzed the relation between MODIS Surface Albedo of various surface coverage types and NDVI. It worked out that the sequence of surface albedos in different kinds of areas are shown in the following: grassland > urban area > cropland > wetlands > water. The surface albedos of water, wetland, unban area and cropland are linearly correlation with NDVI, and the surface albedos of grassland and woodland are negatively linearly correlation with NDVI.

1. INTRODUCE

The temperature of Earth has raised 0.7 degrees centigrade in the past 100 years. The changes of global warming already play a profound effect on the ecosystem and human society, as a result, the global warming problem is becoming one of the most hot issues in recent researches on earth science. We commonly believe that the main reason of the global warming is the so called 'greenhouse effect' which result from the high concentration of greenhouse gases in the air. However, with more researches on global climate changes, researchers gradually know that the surface albedo also affects the global climate significantly. In the last 100 years (1906–2005), the linear trend of global warming is an advance of 0.74 degrees centigrade (0.56–0.92), the temperature rises in high latitude area of the Northern Hemisphere is relatively more obvious. It is given that the areas with higher surface albedo can reflect more solar radiation into outer space, and as a result can relief temperature rise. With this reason, researchers care more about the influences and responses of climate changes which surface albedo result in. It is important to precisely obtain the parameters of surface albedo and to study its change and distribution characteristics since its significant meaning in study of regional climate change and its improvement and validation in land surface process. We know that the surface albedo is mainly affected by underlying surface regime, solar altitude, meteorological condition and other factors, and the underlying surface regime which includes land cover types and NDVI is the key factor that influences the surface albedo.

2. DATA AND PROCESSING

2.1. Research Area

In order to analyze the relationship between surface albedo from MODIS and underlying surface regime in Liaoning Province, in this paper, we choose 6 kinds of typical surface features which are water, wet land, urban area, glass land, farmland and forest land to process study. In each kind, we select 4 research regions to do the statistical analysis, the district distribution are shown in Table 1.

The Liaoning Province is located in east coast of Eurasia, belonging to temperate continental monsoon climate zone. It is showed that the area is characterized by nonuniform rainfall, abundant sunshine, rainy season which coincided with high temperature, high accumulated temperature, longer winter when compared to summer, wetter east when compared to west and shorter spring and autumn. The amount of precipitation in east hilly area is more than 1100 millimeters per year; and the amount of precipitation in west hilly area that connected with Inner Mongolia plateau is around 400 millimeters per year, which is the least precipitation area in the whole province; in its central plains, the amount of precipitation is relatively moderate, which is around 600 millimeters per year.

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Table 1: District distribution.

Plot name	Latitude (° ′ ″)	Longitude	Ecotype	Plot name	Latitude (° ′ ″)	Longitude	Ecotype
Baishi reservoir	N 41 42 02	E 120 59 17	water	Dalian grassland	N 39 37 48	E 122 33 00	grassland
Hun River	N 41 49 30	E 124 08 25	water	Fuxin grassland	N 41 15 00	E 121 40 48	grassland
Gedalou reservoir	N 40 58 04	E 122 08 47	water	Chaoyang grassland	N 41 30 00	E 119 38 24	grassland
Dahuofang reservoir	N 41 53 03	E 124 10 48	water	Huludao grassland	N 40 48 00	E 119 50 24	grassland
Shenyang wetland	N 41 16 12	E 122 13 48	wetland	Beisijiazi village	N 42 39 03	E 122 06 26	cropland
Dalian wetland	N 39 27 36	E 121 24 36	wetland	Beiwanzi village	N 41 26 25	E 119 49 26	cropland
Panjin wetland	N 40 53 24	E 121 58 12	wetland	Houliu village	N 40 46 50	E 122 21 54	cropland
Tieling wetland	N 43 06 36	E 124 52 12	wetland	Zhaojiawobao area	N 42 57 27	E 123 55 07	cropland
Shenyang	N 41 48 18	E 123 27 23	urban area	Qingshangou area	N 42 10 38	E 124 07 52	woodland
Liaoyang	N 41 15 40	E 123 11 17	urban area	Toudaogou area	N 42 10 38	E 124 51 27	woodland
Dalian	N 38 54 43	E 121 38 29	urban area	Daheishan area	N 40 52 07	E 123 33 45	woodland
Huludao	N 40 45 00	E 120 50 58	urban area	Bingyugou area	N 40 02 55	E 122 56 41	woodland

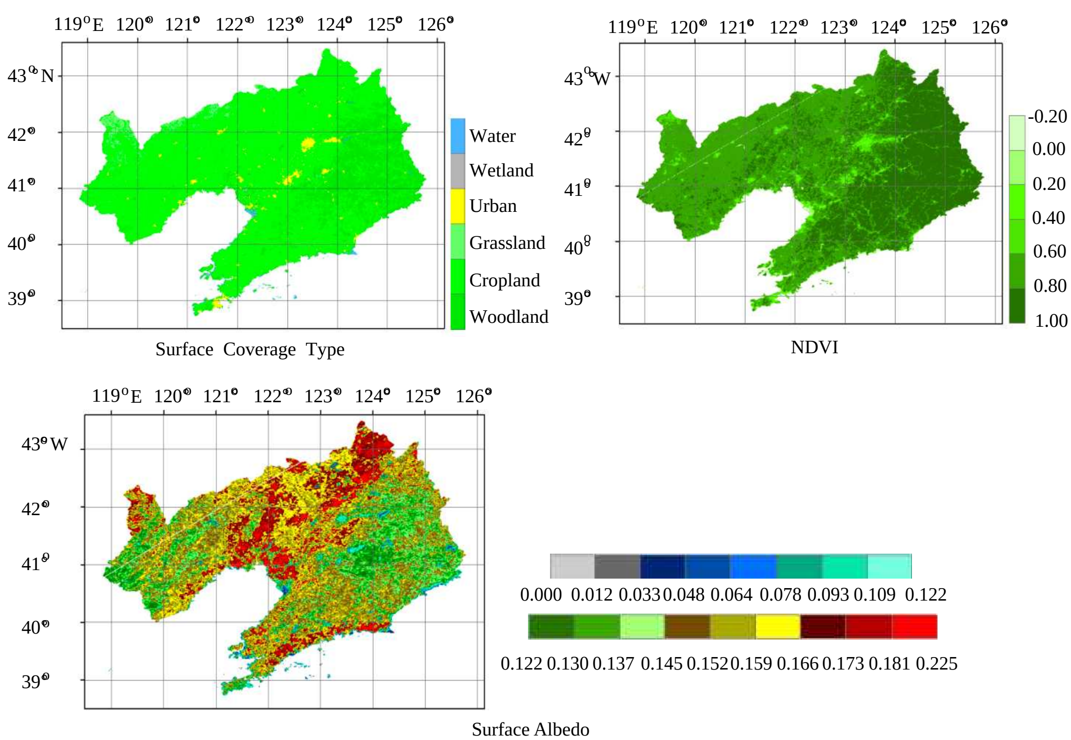

Figure 1: Maps of surface coverage type, NDVI and surface albedo.

2.2. Data Sources

In this paper, we adopted MOD43B3, MOD13A2, MOD12Q1 from MODIS data on August 12, 2012. The surface albedo image of Liaoning Province, NDVI image and the image of surface coverage type which are after processing are shown in Figure 1.

2.3. Data Processing

In this paper, we overlaid the surface albedo image, NDVI image and the image of surface coverage type, all of which are after processing, and with the help of ENVI, we output its outcome to EXCEL to figure out the average value of surface albedo of different surface coverage type and the relationship of each surface coverage type and NDVI.

3. RESEARCH RESULTS

The relationships of different surface coverage types and statistics of surface albedo are shown in Table 2, and the relation of surface albedos and NDVI in different areas of Liaoning with different surface coverage are studied and only one of each kind (water, wetland, urban, grassland, cropland, woodland) is shown in Figure 2, in which y represents surface albedo WSA and x represents NDVI.

3.1. Comparison of Different Surface Coverage's Albedo

According to Table 2, we can figure out the sequence of features based on their values of NDVI was the following: woodland > cropland > grassland > urban area > wetlands > water, and the sequence of features based on their values of surface albedo was the following: urban area > grassland > cropland > woodland > wetlands > water. From this sequence, we can find that with

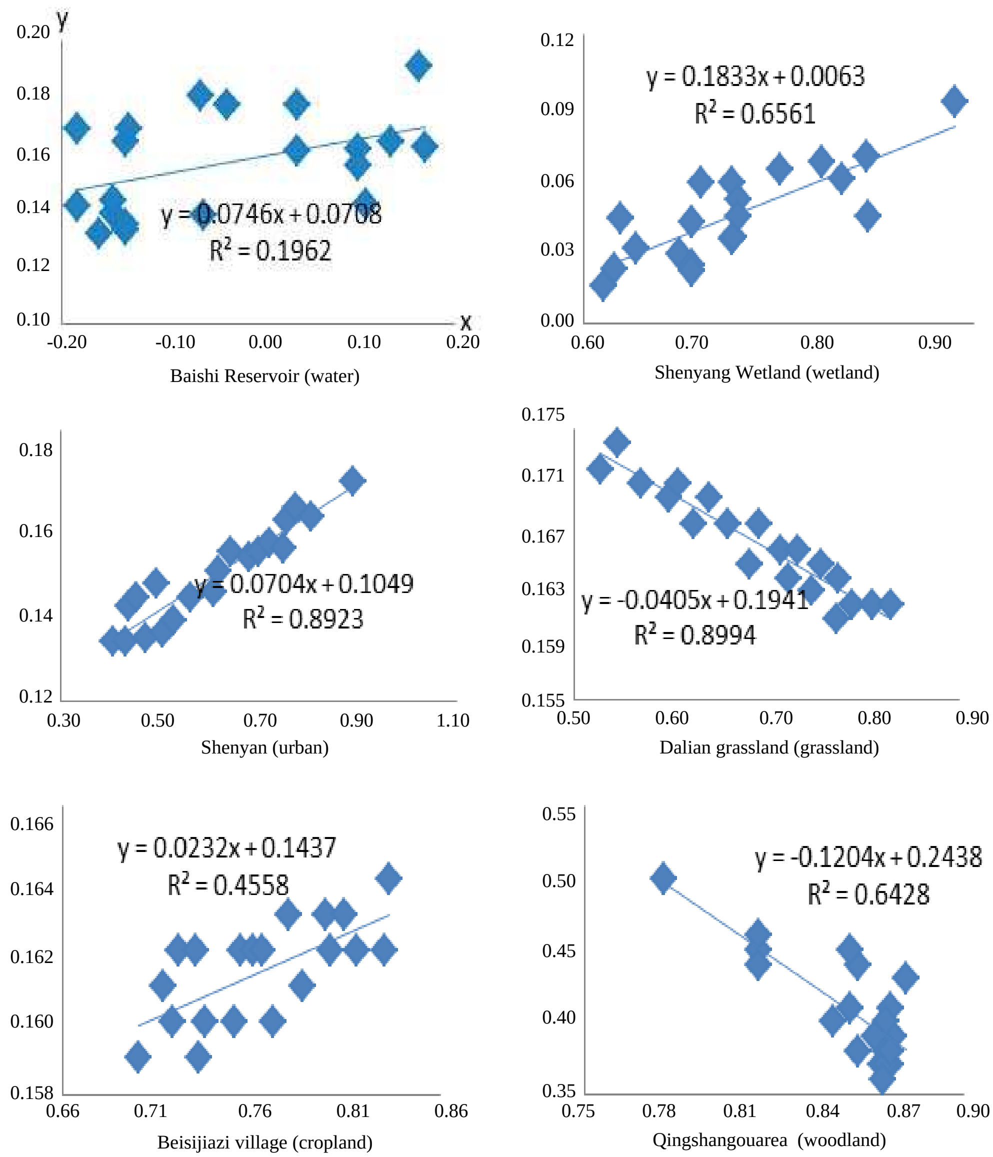

Figure 2: Relationship of MODIS Surface Albedo and NDVI in different Surface Coverage Types of Liaoning.

Table 2: The relationship between statistical value of surface coverage type and albedo.

surface coverage type	Mean of NDVI	Mean of albedo	Median of albedo	Mode of albedo
Water	0.0384	0.0484	0.0440	0.0400
Wetland	0.5757	0.1047	0.1070	0.1050
Urban area	0.6211	0.1503	0.1525	0.1510
Grassland	0.6999	0.1581	0.1590	0.1610
Cropland	0.7964	0.1482	0.1490	0.1490
Woodland	0.8583	0.1384	0.1390	0.1390

the increase of surface albedo, surface coverage type is gradually changed from woodland which is covered best (Since the specular reflection of water, the albedo of water and wetland are very low) to grassland which is covered worst (we speculate that the reason of higher albedo in urban area compared to albedo of grassland is that the specular reflection of building surface material).

3.2. Relationship of WSA and NDVI

3.2.1. Water

The WSA is linearly correlation with NDVI, and value of their correlation index is quite low, the value of R_2 is only around 0.2 (except the Gadalou reservoir which is 0.7956), the values of WSA mostly converge on 0.3 to 0.6, and the values of NDVI mainly concentrate on -0.2 to 0.2, they are relevant most when the value of NDVI is between -0.2 to 0.

3.2.2. Wetland

The WSA is linearly correlation with NDVI, and value of their correlation index is quite high, the value of R_2 is around 0.8 and even reaches 0.9625, the values of WSA mostly converge on 0.06 to 0.13, and the values of NDVI mainly concentrate on 0.6 to 0.8.

3.2.3. Urban Area

The WSA is linearly correlation with NDVI, and value of their correlation index is quite high, the value of R_2 is around 0.8 and even reaches 0.8923, the values of WSA mostly converge on 0.13 to 0.16, and the values of NDVI mainly concentrate on 0.5 to 0.8.

3.2.4. Grassland

The WSA is negatively linearly correlation with NDVI, and value of their correlation index is quite high, the value of R_2 is around 0.9 and even reaches 0.9071 the values of WSA mostly converge on 0.12 to 0.17, and the values of NDVI mainly concentrate on 0.6 to 0.8.

3.2.5. Cropland

The WSA is linearly correlation with NDVI, and value of their correlation index is not too high, the value of R_2 is around 0.5 (except the Houliu village which is 0.7956), the values of WSA mostly converge on 0.15 to 0.18, and the values of NDVI mainly concentrate on 0.7 to 0.8.

3.2.6. Woodland

The WSA is negatively linearly correlation with NDVI, and value of their correlation index is quite high, the value of R_2 is around 0.7 and even reaches 0.8137 the values of WSA mostly converge on 0.13 to 0.17, and the values of NDVI mainly concentrate on 0.7 to 0.9.

4. CONCLUSIONS

Above researches show that in Liaoning area the sequence of features based on their values of NDVI was the following: woodland > cropland > grassland > urban area > wetlands > water, the sequence of features based on their values of surface albedo was the following: urban area > grassland > cropland > woodland > wetlands > water. NDVI and surface albedo of the different land cover types (except wetlands and water bodies) showed a significant negative correlation.

In the same land cover types, the surface albedo and surface coverage type are obviously related (except water). NDVI and surface albedo of water, wetlands, urban and cropland were a positive linear correlation, NDVI and surface albedo of grassland and woodland were a negative linear correlation. This study provided a reference for feature extraction and regional climate change monitoring in Liaoning Province.

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