Analysis of EVI and NDVI Characteristics in Different Land Cover Types in Liaoning Province

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Abstract— For four types of land cover in Liaoning province, the variations of their EVI and NDVI basing on MODIS data in time series were studied in this paper. The result can offer a method of monitoring land cover types. The characteristics of EVI and NDVI from four kinds of land cover, including woodland, cropland, water and urban area, were analyzed by the data statistics method whose data were from 16 regions of interest in Liaoning province basing on 2012 MODIS data. In the woodland coverage areas, the shape of their NDVI and EVI in time series looked like a bell-shaped curve in the period of forests turning green and growing, NDVI was prone to become saturated, and could not show the growth process of trees while EVI could better do that. In the cropland coverage area, the shape of their NDVI and EVI in time series looked like an inverted V-shaped curve in the period of crops growing season. In the water coverage areas and urban areas, the values of their NDVI and EVI were slightly higher in the summer than other seasons, and the annual variation range of their NDVI and EVI was small. In the cropland coverage areas, both NDVI and EVI could well show the process of vegetation growth. In the water coverage areas and urban areas, NDVI sensitively was influenced by noise, while EVI could overcome this shortcoming. The curves shape of NDVI and EVI under different land cover types is of great significance for vegetation classification and extraction in Liaoning province. The figures characteristics of NDVI and EVI indicate that EVI can well monitor the growth of forest in the woodland coverage areas, both NDVI and EVI can monitor the growth of crops in the cropland coverage area, and EVI can well monitor the growth of vegetation in the water coverage areas and urban areas.

1. INTRODUCE

The vegetation information on remote sensing image can be reflected by vegetation indexes, EVI and NDVI are two of those vegetation indexes wide used. At present, those two vegetation indexes are applied to a variety of fields, such as vegetation classification, crop yield estimation, land cover change, relationship of the soil moisture content and the rainfall, ecological environment monitoring, foreign scholars early started to study the vegetation information by vegetation indexes and had got a lot of achievements. After Huete et al. studied vegetation index product, they found that EVI and NDVI of the biotic formation in different regions were sensitive to seasonal change, land cover change and biophysical parameters change [1]. Huiqing Liu and Huete demonstrated that NDVI was highly relevant to EVI and the value of NDVI was always bigger than EVI when the soil background and the atmospheric aerosol vary less. Domestic research on those two vegetation indexes is in the beginning. Wang Zhengxing and Liu Chuang et al. demonstrated that EVI overcame drawbacks of NDVI and improved linear relation between vegetation index and vegetation density [2]. Cheng Qian and Huang Jingfeng et al. analyzed the vegetation indexes based on MODIS in Zhejiang Province and Xianju County, and the result showed that comparing to NDVI, EVI was prone to lower value, normal distribution, uneasy to be saturated and suitable for monitoring high biomass groups [3].

The vegetation indexes are often affected by a lot of factors such as climate, geographic positions, soil, atmospheric reflectance, sensors etc. Therefore, it is necessary to choose the vegetation indexes which are less affected by those factors in application. In this paper the characteristics of two vegetation indexes in time series and the relationship of them in different land cover types in Liaoning Province were studied. The result could provide a method of monitoring dynamically vegetation in Liaoning Province.

2. DATA AND PROCESSING

2.1. Research Area

Liaoning Province locates in the east coast of Eurasia and belongs to temperate continental monsoon climate zone. Because of the complicated terrain, including mountain land, plain, hills area

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and coastal land, each region has its own climate in Liaoning Province. The general climate characteristics are: long cold period, strong plain wind, wet east and dry west, concentrated rainfall, abundant sunshine, four distinctive seasons. In order to study the characteristics of NDVI and EVI in different land covers, four types of typical land cover (woodland, plowland, water and urban area) were chose to study with four regions as samples respectively. The distribution and types of land cover were showed in Table 1.

Table 1: Sample area.

land cover type	Sample area
woodland	Qingshan gou, Toudao gou, Daheishan, Bingyu gou
plowland	Beisijiazi, Beiwanzi, Houliu cun, Zhaojiawo bao
water	Baishi reservoir, Hunhe river, Gadalou reservoir, fengchengyulong lake
Urban area	Shenyang, Liaoyang, Dalian, Huludao

2.2. Data

Vegetation index consists of red and infrared light reflectance in accordance with spectral reflectance characteristics of green plants, and it is simple and effective to monitor vegetation cover and its growth conditions. NDVI is dimensionless data by operation among spectral channels and is empirical or semi empirical index on vegetation. Its expression is as follow:

$$\text{NDVI} = \frac{\rho_{nir} - \rho_{red}}{\rho_{nir} + \rho_{red}} \tag{1}$$

For MODIS data, ρ_{nir} and ρ_{red} are the 2nd and 1st MODIS spectral reflectance data respectively [4–7]. According to the statistics of NDVI, the areas of low vegetation cover are more sensitive and the areas of high vegetation cover are prone to be saturated. Moreover, NDVI is easily affected by atmospheric noise and soil background. However, EVI corrected the surface reflectance to be more sensitive to high biomass and took advantages of coupling canopy background signal as well as reducing atmospheric influence to improve the precision of vegetation monitoring. Its expression is as follow:

$$\text{EVI} = 2.5 \times \frac{\rho_{nir} - \rho_{red}}{L + \rho_{nir} + C_1\rho_{red} - C_2\rho_{blue}} \tag{2}$$

ρ_{blue} is the reflectance of blue band referring to 3rd band reflectance of MODIS. L is the parameter of soil regulating, its value is 1. C_1 is the calibration parameter of red light, its value is 6. C_2 is the calibration parameter of blue light, its value is 7.5 [8, 9].

In this paper, the data were MODI13A2 at a time resolution of 16 days and a space resolution of 1 km in 2011. There were 23 periods of processed vegetation index data.

2.3. Processing

Through image projection conversion, subsetting, mosaicing, stacking and other steps, NDVI and EVI data in Liaoning Province were acquired, and were spotted together in time series. The correlations of NDVI and EVI in woodland, plowland, water and urban area were counted and analyzed.

3. RESULT ANANLYSIS

Linear correlation between NDVI and EVI were shown in Table 2, R^2 represents correlation coefficient of two vegetation indexes. Seasonal time sequence of vegetation index were studied and only one of each kind (woodland, cropland, water, urban) was shown in Figures 1, 2, 3, 4, where the horizontal axis and the vertical axis represent time and two vegetation indexes values respectively. From Table 2, we could find that linear correlation of between NDVI and EVI in woodland and cropland higher, while in urban area and water lower.

3.1. Features of Vegetation Indexes in Woodland

Figure 1 showed that the value of NDVI was higher than EVI in woodland of Liaoning, both reflected responsively the vegetation growth condition in woodland with seasons change and were in a same trend and looked like bell-shaped curve that were changed with the season obviously. In the 97th day to the 129th day, that EVI and NDVI grew rapidly indicated that the process of

Table 2: The linear correlation of two vegetation index.

sample	correlations	R^2	Land cover types
Qingshangou	$y = 0.921x + 0.279$	0.888	Woodland
Toudaogou	$y = 1.328x + 0.112$	0.923	Woodland
Daheishan	$y = 1.251x + 0.173$	0.932	Woodland
Bingyugou	$y = 1.189x + 0.164$	0.951	Woodland
Beisijiazi	$y = 1.488x + 0.014$	0.973	Plowland
Beiwanzi	$y = 1.636x + 0.032$	0.980	Plowland
Houliucun	$y = 1.528x + 0.061$	0.941	Plowland
Zhaojiawobao	$y = 1.416x + 0.016$	0.966	Plowland
Baishireservoir	$y = 3.963x - 0.004$	0.602	Water
Hunhe river	$y = 1.774x - 0.043$	0.612	Water
Gedalou reservoir	$y = 1.781x - 0.041$	0.799	Water
Fengchengyulong lake	$y = 2.686x - 0.003$	0.583	Water
Shenyang	$y = 2.185x + 0.023$	0.874	Urban area
Liaoyang	$y = 1.739x + 0.027$	0.872	Urban area
Dalian	$y = 0.839x + 0.104$	0.528	Urban area
Huludao	$y = 1.533x + 0.026$	0.847	Urban area

vegetation re-becoming green was obvious. In the 129th to the 273th day, that EVI and NDVI were stable comparatively indicated that the woodland was in the period of flourishing. In the 177th day to the 193rd day, there was a peak of EVI while the transition of NDVI was smooth without fluctuation, the phenomenon indicated that in the period of woods flourishing, NDVI was easy to be saturated and could not reflect the growth situation of vegetation significantly, while in other time NDVI was sensitive and fluctuated more evidently than EVI.

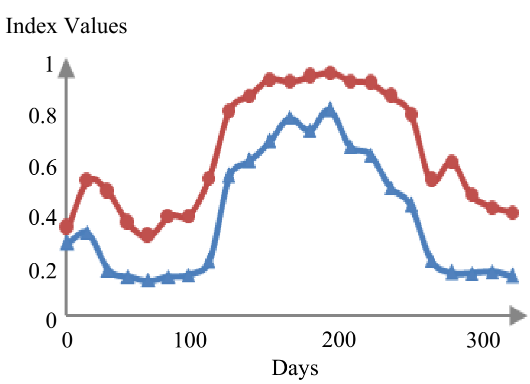

Figure 1: Qingshan gou woodland.

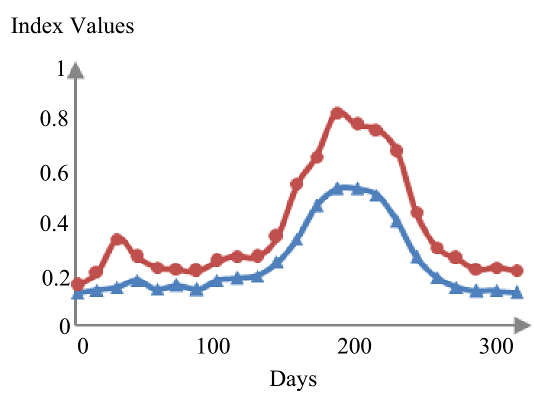

Figure 2: Beisijiazi farmland.

3.2. Features of Vegetation Indexes of Cropland

From Fig. 2, we could find that: In the croplands of Liaoning province, the value of NDVI was always higher than EVI; Both of the two vegetation indexes were V-shaped curve and had same variation tendency; Both of the two vegetation indexes reflected the process of vegetation growth compared to the woodland, EVI and NDVI of croplands increased rapidly one month later. In the 129th to the 193rd the increase of EVI and NDVI were comparatively rapid but gentle compared to the woodland. It indicated that the corps was in the period of growth. When EVI and NDVI reach to the peak, then they decreased rapidly rather than fall slowly. It indicated that the corps had a short period of flourishing

3.3. Features of Vegetation Indexes of Water

From Fig. 3, we could find that in the 129th day to the 257th day, both of the two vegetation indexes were higher than any other time and the values of them were positive. It indicated that the values had something with water chlorophyll at that time in the period, NDVI fluctuated dramatically at some points. It indicated that NDVI was greatly affected by noise, but EVI was comparatively gentle and less affected by noise. In the other time, the value of EVI and NDVI fluctuated around zero and most of the values were negative.

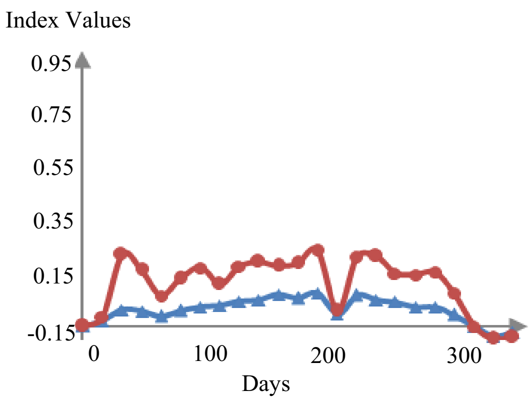

Figure 3: Baishi reservoir.

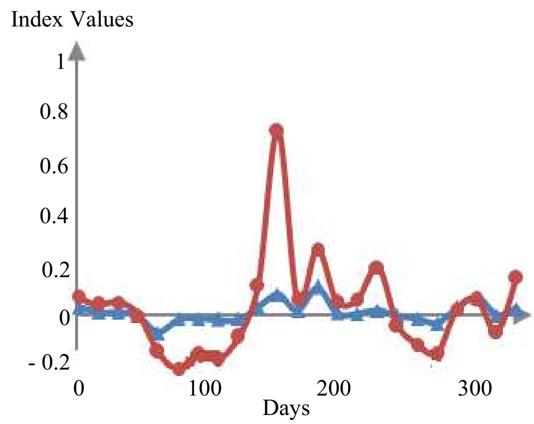

Figure 4: Shenyang.

3.4. Features of Vegetation Indexes of Urban Area

From Fig. 4, we could find that both of the vegetation indexes were lower than plowland and woodland. At some points NDVI fluctuated dramatically, it indicated that when detecting urban area, NDVI was affected by noise greatly, while EVI overcame the shortcoming well.

4. CONCLUSIONS

1. In Liaoning province, NDVI and EVI of woodland show bell-shaped curve, NDVI and EVI of plowland show inverted V-shaped curve, NDVI and EVI of water don't show specific curve, while NDVI and EVI of urban area show arc curve. So the curve shape of NDVI and EVI in different land cover is of significant importance for vegetation classification and extraction.

2. In Liaoning province, the period of trees turned green is in early April to early May, the period of trees flourishing is in early May to early October. The period of corps growing is in early May to middle of July and the period of corps flourishing is short.

3. In the period of trees flourishing, NDVI is prone to be saturated while EVI can overcome it well so as to monitoring the growth of trees. In the period of corps growth, both of the vegetation indexes can reflect the process of corps growth well. In the water and urban area, NDVI is easy to be affected by noise while EVI can overcome it and monitor the growth of vegetation well.

REFERENCES

1. Huete, A., K. Didan, and T. Miura, "Overview of the radiometric and biophysical performance of the MODIS vegetation indices," *Remote Sensing of Environment*, Vol. 83, No. 1, 195–213, 2002.
2. Wang, Z. X., C. Liu, and A. Huete, "From AVHRR-NDVI to MODIS-EVI: Advances in vegetation index research," *Acta Ecologica Sinica*, Vol. 23, No. 5, 979–987, 2003.
3. Cheng, O., J. F. Huang, and Wang R. C., "Preliminary analysis of difference between MODIS and NOAAI AVHRR vegetation indices," *Bulletin of Science and Technology*, Vol. 21, No. 2, 205–209, 2005.
4. Matsushita, B., W. Yang, and Chen J., "Sensitivity of the enhanced vegetation index (EVI) and normalized difference vegetation index (NDVI) to topographic effects: A case study in high-density cypress forest," *Sensors*, Vol. 7, No. 11, 2636–2651, 2007.
5. Schucknecht, A., S. Erasmi, and I. Niemeyer, "Assessing vegetation variability and trends in north-eastern Brazil using AVHRR and MODIS NDVI time series," *European Journal of Remote Sensing*, Vol. 46, No.1, 40–59, 2013.
6. Caroline, P., M. Lewis, and D. White, "Monitoring temporal dynamics of Great Artesian Basin wetland vegetation, Australia, using MODIS NDVI," *Ecological Indicators*, Vol. 34, No. 11, 41–52, 2013.

7. Cui, X. L., J. Zhang, and H. H. Y. Bai, "Analysis of vegetation cover change in Shanxi Province based on modis NDVI," *Journal of Northwest A&F University: Natural Science*, Vol. 41, No. 5, 1–7, 2013.
8. Nicholas, C., J. Rogana, and Z. Christman, "Modelling dry season deciduousness in Mexican Yucatán forest using MODIS EVI data," *GIScience* & *Remote Sensing*, Vol. 50, No. 1, 26–49, 2013.
9. Yudi, S. and K Yoshino, "Detecting land-use change from seasonal vegetation dynamics on regional scale with MODIS EVI 250-m time-series imagery," *Journal of Land Use Science*, Vol. 1, No. 7, 243–248, 2012.