

Spatial Correlations of Land Cover Changes, Surface Temperature and NDVI in Arid Regions: A Case Study in Kashgar City, China

*Ayisulitan Maimaitiaili¹, Abudureheman taiwaikuli², Ayishainmuguli Abulati³, Akihiko Kondoh⁴

1. Graduate school of science ,Chiba University, 2. School of Science and Technology, Geology Division, University of Camerino, Italy, 3. Kashgar Meteorological Agency, 4. Center for Environmental Remote Sensing, Chiba University

Land surface temperature (LST) is one of the important parameters in the physics of land surface processes from local to global scales. Researches on urban LST have increased and mitigations only focused on the big cities already developed. In contrast, there are few attentions to developing cities with large populations. Kashgar city is one of the typical city in arid regions, and is located in north-west China, south-west of Xinjiang Uyghur Province of China. Population reaches more than 506,640 in 2014. With increasing population, expansion of urban area has accelerated temperature rise in Kashgar city. Originally, a high temperature in the area is inherent in continental arid climate combined with increasing anthropogenic activities, urbanisation, resulted from impacts on the local environment changes, such as local warming. For these reasons, local government have to need to measurements to adopt local climate change but it is difficult to know how and when to adopt. Therefore the main objective of this study is first, to investigate land use/cover changes (LUCC) of Kashgar city by using multi-temporal satellite remote sensing data, through an objective-based image classification method by the eCognition. Land use changes are studied based on change detection method. Second, calculated NDVI as the ratio between measured reflectance in red (R) and near-infrared (NIR) spectral bands of Landsat images, to examine the relationship between LST and greenness. Third, to produce LST map applied the mono-window algorithm by using the thermal band of Landsat data. Finally, validation of satellite-derived LST using local meteorological data. Results from the LUCC and change detection shows that an increase in impervious surface areas was significant, while an area of cultivated land and natural vegetation decreased rapidly. The surface of Kashgar city is mainly dominated by bare land, built-up land and marble surface material. This area showed very high temperature. The changes in LUCC were found to have led to a variation in surface temperature, as well as a spatial distribution pattern of the local warming. In addition, the results from the higher value of Moran`s index of a city center, where built up rooftops and marble surface. The NDVI and LST results will provide helpful information for local governments with development guidelines and policy decisions.

Keywords: Arid Region , Kashgar City, LST

Estimation of Water Consumption of Winter Wheat in the North China Plain Using Remote Sensing Technology

*Xifang Wu^{1,2}, Yanjun Shen², Akihiko Kondoh³

1. Graduate School of Science and Engineering, Chiba University, 2. Center for Agricultural Resources Research, Institute of Genetics and Developmental Biology, Chinese Academy of Sciences, 3. Center for Environmental Remote Sensing, Chiba University

The North China Plain (NCP) is one of the most important regions of agricultural production in China. Winter wheat is a major crop in this region. Water consumption of winter wheat greatly exceeds precipitation of the same period. Increase of winter wheat yield mainly depends on irrigation. Over-exploitation of groundwater resources for irrigation has resulted in the decline of the groundwater table and severe environmental problems. The objective of this study is to accurately estimate crop water consumption and irrigation water consumption in the study area. A model to estimate actual crop evapotranspiration was established combining Penman-Monteith method with remote sensing data. Estimated actual evapotranspiration of winter wheat between 2001 and 2013 had good consistency with field observed evapotranspiration in Luancheng Station of Hebei Province, Weishan Station and Yucheng Station of Shandong Province (RE= -1.3%, RMSE=54.8mm). Irrigation water consumption also had good consistency with declining rate of groundwater table at hydrological stations of Hebei Plain. Moreover, planting area of winter wheat in Northern Hebei Plain and Southern Hebei Plain had a declining trend from 2001 to 2013. Before and after 2001, decline rate of regional groundwater table of Northern Hebei Plain and Southern Hebei Plain decreased significantly. Thus, decrease of planting area of winter wheat had a significant influence on protection of groundwater resources. The proposed model in this study can also be applied in the estimation of water footprint and irrigation water management in other regions.

Keywords: North China Plain, Evapotranspiration, Remote sensing, Groundwater, Irrigation water consumption

Asymmetric temperature sensitivities of plant phenology in warmer and cooler springs are affected by climate factors in Europe

*Tong Zhou¹, Yanhong TANG¹, Shilong Piao¹, Cong Wang

1. Department of Ecology, Peking University

Understanding temperature sensitivity of vegetation is important for predicting the effects of climate change on terrestrial ecosystem. Previous studies paid much attention on phenological response of plants to temperature elevation. Temperature elevation has induced and is expected to induce high temperature fluctuations combining with changes in other climate factors. However, little attention has been paid on phenological responses to temperature variations under different background temperature and these responses in relation to other climate factors.

Using the European phenology database PEP725, we examined the species-specific temperature sensitivities in warmer springs and cooler springs for start of spring (SOS) of woody species with more than 30 years phenological observations. Linear regression analyses were applied to determine the temporal correlations between SOS and spring temperature in warmer and cooler springs, and correlation analyses were further used to assess the relationship between temperature sensitivities and other factors.

We found that phenological responses to temperature in warmer springs (T_{sw}) were significantly greater than in cooler springs (T_{sc}). In warmer springs, the temperature sensitivity was higher in response to decreasing spring temperature. Moreover, we found that the temperature sensitivity varies with chilling days and precipitation. This study suggests that phenological sensitivity to temperature variation may differ in springs with different temperatures, i.e., temperature sensitivity is asymmetric between a warm and a cold spring, and the differential response can be further interacted with other climate factors.

Keywords: Phenology, Europe, temperature sensitivity

Applying Desertification Monitoring Method to Mu Us Desert Considering Seasonal Changes

*YoungHyun Koo¹, Myeongchan Oh¹, Chang-Uk Hyun², Hyeong-Dong Park¹

1. Seoul National University, 2. Korea Polar Research Institute

Desertification is one of the biggest environmental issues that we face today. There have been significant efforts to reduce the impacts of desertification and restore ecosystems affected by it, being reforestation the most common mitigation measure applied. In order to maximize these efforts, it is necessary to monitor the desertification of those regions. As remote sensing technique is suitable to detect environmental changes in large area, it has long been used for monitoring desertification. Most of previous studies focuses on calculating vegetation index (e.g. NDVI) or classifying land cover from satellite images of specific period in a year. In those studies, however, only satellite images of summer are used for monitoring. As the distribution of vegetation varies over seasons or months, using only satellite images of a specific period like summer has a limitation in analyzing overall desertification tendency. Therefore, this study focuses on detecting band radiance changes of each pixel over the time, and designs Time Dependent Desertification Index (TDDI). Landsat satellite images of Mu Us desert, Inner Mongolia, in various seasons from 2007 to 2016 are used to analyze the desertification index. The TDDI value map of the Mu Us desert area is produced and it is expected to help identify overall tendency of desertification considering seasonal factors. Furthermore, this new method can be applied to other environmental fields where seasonal changes need to be considered.

Keywords: monitoring, desertification, remote sensing, Mu Us desert

Possible Impacts of Returning Farmland to Forest and Grassland on Local Temperature in the Ecotone between Agriculture and Animal Husbandry in China

*Feng Tang¹, Rui Mao^{1,2}, Ying Ma^{1,2}

1. Beijing Normal University, 2. State Key Laboratory of Earth Surface Processes and Resource Ecology

LUCC activities change the surface albedo, evapotranspiration and other biological geophysical processes and carbon cycling, greenhouse gas emissions and other bio-geochemical processes, so that at different time and space scale, the local, regional and global scale climate impact. Using the LUCC data, the meteorological stations were divided according to the land use types, and the adjacent sites were matched in space. The temperature difference between the paired sites was analyzed. It was found that the conversion of cropland to forest and grassland was significantly lower in the growing season effect. In the case of precipitation precipitation, the trend of summer temperature difference between the site of returning farmland to forest site and its invariable site is $-1\text{ }^{\circ}\text{C} / 10\text{a}$, while that of returning farmland to grass is the most obvious in spring, the trend is $-0.3\text{ }^{\circ}\text{C} /$ The effect of returning farmland to forest is more obvious than that of returning farmland to grassland, and the effect of cooling is not significant.

Keywords: Climate Change mitigation, surface cooling, Returning Farmland to Forest and Grassland Effect

Remote Estimation of Euphotic Zone Depth for Turbid Inland Waters: A Case Study in Lake Kasumigaura, Japan

*Wei Yang¹, Bunkei Matsushita², Takehiko Fukushima², Akihiko Kondoh¹

1. Chiba University, 2. University of Tsukuba

Euphotic zone depth (Zeu) is defined as the depth where photosynthetic available radiation (PAR) is 1% of its surface value. It is of great importance in studying water biogeochemical processes. Satellite remote sensing is a powerful technique to monitor Zeu, as it can cover large areas at very frequent intervals. Several remote-sensing algorithms for estimating Zeu have been developed for oceanic water bodies; however, remote estimation of Zeu is still a challenging task for inland waters. In this study, an existing semianalytical algorithm was modified for remotely estimating Zeu in turbid inland waters by replacing the original quasi-analytical algorithm (QAA) by QAA_Turbid, an algorithm specially developed for remotely estimating total absorption and backscattering coefficients in turbid waters. Performance of the modified algorithm was evaluated using *in situ* radiometric data collected in Japan's Lake Kasumigaura, known to be very turbid. Results showed that yielded acceptable estimation accuracy for Zeu (ranging from 1.15 to 2.26 m) with root-mean-square error (RMSE) of 0.12 m, normalized root-mean-square error (NRMS) of 8.01%, and mean normalized bias (MNB) of -1.84%, significantly outperforming the original version as well as three other Zeu retrieval algorithms. Application to the satellite images also yielded acceptable performances. These results indicate its great potential for operational estimation of Zeu over widespread turbid inland waters from satellite observations.

Keywords: Euphotic zone depth, remote sensing, inland waters

An Automatic Land Cover Updating Algorithm Based on NDVI Downscaling and Object-oriented Change Detection

*Xin Cao¹

1. Faculty of Geographical Science, Beijing Normal Univ

Land cover mapping and continuous updating are of great significance to climate change and land resource management. Recently, China released the first 30-m global land cover product GlobeLand30 with two years (2000/2010). GlobeLand30 was produced by a pixel-, object- and knowledge-based (POK) information extraction strategy, which guarantees high accuracy and consistency globally. However, the POK method cannot allow an automatic and quick updating for this product, and the existing land cover updating method has a lot of problems, e.g. the pixel-based classification method is not suitable for the high resolution image, and the pseudo-changes remove method based on the pixel NDVI time series results in 'salt and pepper' phenomenon. Thus an effective and efficient land cover product updating method is urgently needed. To address these problems, this research aimed to automatically update GlobeLand30 at object scale with downscaling NDVI time series data.

The automatic updating method involves two main algorithms. (1) Land cover updating algorithm by integrating downscaled NDVI time series. This algorithm requires the land cover map at time T_1 , Landsat images at time T_1 and T_2 , and MODIS yearly NDVI time series data at two years. The MODIS NDVI time series data at 250m resolution was downscaled at 30m by NDVI-LMGM model (Rao et al., 2015, doi:10.3390/rs70607865). All pixels in the T_1 and T_2 Landsat images are selected as training samples individually corresponding to the land cover map at T_1 , and then we get the posterior probability of pixels belonging to every class. Then change pixels are detected by change vector analysis in posterior probability (CVAPS). Finally, the changed pixels are removed from both training samples, and classification and the change detection repeatedly until the changed/unchanged pixels between two iterations are 99% consistent. (2) Land cover updating method based on object-oriented analysis. The Landsat images are firstly segmented and an optimal scale factor is determined by the method proposed by Yang et al. (2016, doi:10.1109/JSTARS.2016.2615073). The training sample selection, classification and change detection methods are the same as above.

We choose Beijing/Tianjin/Tangshan region as the study area, and used Landsat OLI data and MODIS NDVI data in 2013 to update the GlobeLand30 2010 product. Result shows that the new method eliminates 'salt and pepper' phenomenon, and the land cover update accuracy is 86.71%. Besides, the optimal scale segmentation can help obtain the highest land cover update accuracy than any single scale segmentation. The object-based NDVI time-series data can help to remove more than 90% pseudo-change caused by phenological difference and spectral confusion. The automatic updating method can help to produce new global land cover maps at 30m spatial resolution.

Keywords: Land Cover Update, Object-based, NDVI downscaling

Detection of plant root orientation using ground-penetrating radar

*Xihong Cui¹, Xin Cao¹

1. Faculty of Geographical Science, Beijing Normal Univ.

With the function of water absorption, nutrient transportation and storage, root system plays a significant role in plant ecosystem^[1]. Nevertheless, subject to the inconvenience of underground investigation, surveys on root system under natural circumstance have lagged far behind those on the aboveground part. Due to its in situ and non-destructive nature, ground-penetrating radar (GPR) has recently been applied for field investigation of plant roots, such as automatic three-dimensional reconstruction of root system and quantitative inversion of root parameters. It is the discrepancy between the roots and surrounding soils that creates a dielectric constant contrast, forming clear hyperbolic reflections on the GPR radargram. The intensity and shape of the reflecting signals from roots are substantially affected by the root orientation and as well the relative geometry between the root in subsurface and GPR survey direction on ground surface. However, no previous study has utilized the information on intensity and shape of root's GPR reflection to map its orientation, which is crucial in interpreting radargram and rebuilding three-dimensional root system architecture. In this study, a mathematical formulation of hyperbolic reflection formed by a single root was first deduced based on principles of electromagnetic wave propagation and the relationship between the shape of the GPR signals and root orientation was analyzed. Then using such formulation, curve fitting was conducted on both simulated and field collected dataset by GPR. Information on the horizontal orientation and vertical inclination of a single root was acquired according to the formulation coefficient retrievals. Based on this, a method for retrieving the horizontal orientation and vertical inclination angle of a single root from a given GPR image was proposed. This method took advantage of mathematical modeling with curve fitting in root orientation estimation. Meanwhile, conditions for this method application and factors impacting on the extraction of root orientation information were analyzed. The results indicated fairly precise root orientation estimation. The proposed method has extended the application of GPR in root investigation, advancing the frontier of non-invasive root system architecture mapping.

Keywords: ground-penetrating radar, root orientation, curve fitting

Environmental assessment of coastal degradation of Southern Corniche of Jeddah coast using remote sensing and GIS

*Satria Antoni¹, Talha Al-Dubai¹, Rashad Bantan¹

1. King Abdulaziz University (KAU)

During the last three decades, human interference with the environment has changed the outlook of the Southern Corniche of Jeddah (SCJ). Satellite images acquired from the Enhanced Thematic Mapper Plus (ETM+) 2010, Thematic Mapper (TM) 1990, Multi-spectral scanner (MSS) 1973 and Ikonos image of 2009 were used to detect of the nearshore zone degradation and to assess environmental changes induced by human activities. The visual interpretation of these images revealed a great change in the shoreline and in coral reef habitats. The reef flats were filled and the coastal land was cut for the purpose of expanding the seaport platforms and constructing of coastal road. This study revealed changes in mangroves as indicated by the loss of the mangrove area and a decline in the rate of growth of mangrove trees (*Avicennia marina*) during the past of 20 years due to anthropogenic activities and high salinity. The present study shows that satellite remote sensing (RM) integrated with geographic information system (GIS) are very effective tools for coastal changes detection. The high-resolution satellite data such as Landsat ETM+ 2010, TM 1990, MMS 1973 and IKONUS 2009 data are excellent source to provide information accurately.

Keywords: Remote Sensing, GIS, Environmental degradation

Multiple Remote Sensing Indicators for Understanding Spatiotemporal Trends Across a Changing Landscape in North and South America.

*Braden Owsley¹, Kirsten de Beurs¹, Geoffrey Henebry²

1. University of Oklahoma, Department of Geography and Environmental Sustainability, 2. South Dakota State University, Geospatial Sciences Center of Excellence (GSCE)

Identifying and understanding the nature of changing landscapes is one of the great challenges in a time of intense Earth observation. There are abundances of remotely sensed data and computing capacity now available to researchers, which enables moving beyond the use of one or a few sensors or datasets for the generation of static or limited land cover/land use products. Using multiple time series datasets at complementary spatial, temporal, and spectral scales to study land surface dynamics should improve the detection and interpretation of complex processes; the result should be a more accurate and detailed analysis of landscape trends, including the distribution and severity of changes and their possible causes and potential consequences. Therefore, we have conducted an analysis based on a variety of remote sensing products covering North and South America across an approximately fifteen-year period with spatial resolutions extending from 500m to 1 degree, including (1) NBAR-based vegetation indices, albedo, land surface temperature, and evapotranspiration from MODIS, (2) air temperature, water vapor, and vegetation optical depth from AMSR-E and AMSR2, (3) surface air temperature, water vapor, and relative humidity from AIRS, and (4) surface shortwave, longwave, and total net flux from CERES. We applied the non-parametric Seasonal-Kendall trend test to these time series, both annually and on a seasonal basis (summer & winter), to identify hotspots of significant change. We partitioned the data by indicators of human impact and ecoregion, such as the Human Influence Index, Anthropogenic Biomes, and Ecoregions of the World.

We formulate our question as a suite of testable hypotheses about changes in the vegetated land surface, as follows:

- (H1) Areas of significant positive change occur in areas of moderate human impact, due predominantly to agricultural land uses;
- (H2) Areas of significant negative change that occur in areas with low human impact, arise predominantly from forest pests and forest fires; and
- (H3) Areas of significant negative changes that occur in areas with high human impact, appear predominantly associated with the expansion of human settlements, particularly cities.

The results indicate significant benefit from the multiple data stream approach to studying land surface dynamics.

Keywords: Global Change, MODIS, AMSR, Human Influence, Ecoregions, Anthromes

Temporal and Spatial Distribution Characteristics of AOT (Aerosol Optical Thickness) and Its Implication in Yangtze River Delta, China

*XiaoYu Zhang¹, Lingling Yao¹, Yixuan Xiong¹, Yong Du¹

1. Zhejiang University

The spatial distribution, seasonal, inter-annual and the periodic variation tendency of aerosol optical thickness (AOT) in Yangtze River Delta were observed with ATSR and MODIS data from 1995 to 2015. Relationships between AOT and urban construction area, car ownership, high pollution industry product output and the consumption of electric power, coal, and fuel are analyzed and the economic and social impacts on aerosol optical thickness over the Yangtze River Delta. The result shows that:

1) The AOT yearly change in Yangtze River Delta shows a gradual increase from 1995-2015 with the average growth rate of 0.04/10a, is consistent with that of the national' s, and plays a stimulating role with the rate of 82%. Three stages can be distinguished: 1995-2002 (the first stage) and 2010-2015 (the third stage) shown an upgrade trend, and the 2002-2010 (the second stage) fluctuates. However, the AOT in this study area grown faster than the national' s in the first stage, whereas the third stage is on the opposite.

2) The AOT monthly change over Yangtze River Delta is in “W” shape with greater fluctuation in contrast to the wave shape of the country. The Yangtze River Delta is characterized with AOT the most obvious enhancement in autumn.

3) The Yangtze River Delta is one of the areas suffering heavy AOT in China. The AOT distribution is impacted greatly by the topography with the high AOT distributing in the low-lying northern plains, while the southern hilly area exhibiting low AOT. The high AOT zone distributes along the western and northern area of Shanghai mega city, and gradually extends northward and south of Jiangsu Province.

4) Transportation, high pollution industry production and fossil energy consumption are common factors impacting the annual variation of AOT in Yangtze River Delta. The decrease of high pollution industry product output recently contributes a lot to the reduction of AOT in Shanghai, which is in consistent with downward increasing trend of AOT during 2010-2015.

Keywords: ATSR, MODIS, AOT, Yangtze River Delta, Human activity