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Plants shifting life-cycle

Plants have been used as an indicator of seasonality and climate throughout human history. Observing the timing of plants life-cycle events, like bud burst, flowering, leaf fall, in relation to changes in season and climate is called phenology. Vegetation adapts according to the climate conditions and it is extremely sensitive to change in temperature, precipitation and day light. Therefore, vegetation is used to study climate change. Many scientific papers from all over the world revealed an advancement and extension of the plants growing season and showed that those phenology shifts are related to recent trends in increase of global temperature.

In this study satellite images, taken from the sensor MODIS were used to depict general plant canopy characteristics. Using mathematical formulas, the raw satellite images were transform into vegetation indices (VI). The vegetation index is a numerical value which indicates the relative health and density of green vegetation in a single satellite image pixel. Furthermore, VIs can be used to estimate phenology phases timings - start, peak and end of the growing season. The Normalized Difference Vegetation Index (NDVI) is one of the traditional vegetation indices and has been used in various applications since it was introduced in the 1970s. However, NDVI and other VIs experience difficulties to retrieve reliable phenology. Mostly because of high sensitivity to snow, by missmatching the melt of the snow with the start of the growing season or insensitivity to seasonal change in dense evergreen vegetation. The Plant Phenology Index (PPI) was formulated in 2014 and it is defined as physically based. Meaning that the index takes into account the physical properties of the plants, like the shape and the angle of the leaves.

The overall goal of this study is to compare how two different VIs - NDVI and PPI, perform in estimating phenology phases - start and end of the season for ecosystems on the Balkan peninsula for the period 2000 to 2016. Generally, both VIs results revealed good agreement with previous studies, by confirming advancing trends in the start of the growing season by around 0.4 days per year in the area. However, the results revealed that PPI and NDVI differ considerably, by diverging by more than one month in estimating start and end of the season dates. After furder analysis, the main conclusion is that PPI showed more reliable performance over NDVI f, esspecially in evergreen forests.

Plant phenology is very usefull for studying climate change, but in practice plants are the fundament of the food chain. For instance, earlier start of bud bursting, can expose plant to spring frost and insects and birds depending on those plants are also impacted. It is important to address those probems on different scales – from the field records to satellite remote sensing and use reliable data in order to conduct precise analysis and have better understanding of how plants life-cycles are shifting.

Keywords: Physical Geography, Ecosystem Analysis, Phenology, Vegetation, Climate Change, Remote Sensing, Plant Phenology Index, PPI, Timesat, Balkan Peninsula

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