Lesson outline

Author/ Authors: Edyta Woźniak

Key words: Global warming

Global Warming impact on vegetation

Topic: Global warming

Students' age: 15-19

Time: 2 lessons

Subjects: geography

LESSONS IDEA - Teacher's guide

The lesson 'Global Warming impact on vegetation' is a part of a 3rd block of 5 lessons devoted to the problem of global warming and its direct and indirect impacts assessment using remote sensing techniques. Global warming is one of the main current threat for human life and well-being, as well as, for plant and animal species then ecosystems.

The purpose of this lesson is to evaluate the impact of climate change on vegetation in different regions using satellite images. The length of growing season will be searched, as well as the intensity of greening. Reflectance of electromagnetic wave will be used to characterize photosynthetic activity of plants.

Lesson objectives

- Active participation in the analysis of real data of different sources
- Stimulating critical view of results

Results

- Students will know how electromagnetic wave interact with plants
- Students will know how to analyze satellite data
- Students will discover plant phenology in various geographic zones
- Students will determine how global warming influences on vegetation

ADDITIONAL MATERIALS:

- presentation global warming vs vegetation.pptx – **Appendix 1**
- MODIS satellite image (MOD2 product reflectance)
- MODIS satellite image (MOD13A1 product NDVI) 2020
- Land cover map https://esa-worldcover.org/en
- sets of ten days composites of NDVI (Normalised Difference Vegetation Index) for following years 2000, 2005, 2010 i 2015

- Software: QGIS, Excel
- QGIS Short Tutorial - Windows 10/11 systems – **Appendix 2**

✍ *The lesson needs to be done in a computer room.*

DESCRIPTION OF THE LESSON

✍ Theoretical part

Impact of climate change on individual tress and on ecosystem will be presented. Next, the possibilities of monitoring of vegetation using satellite data will be shown. A basic information about MODIS - Moderate Resolution Imaging Spectroradiometer will be given. Students will learn about leaf anatomy and processes which take place in leaf and interaction of electromagnetic wave with leaf: reflection, absorption, transmission. What footprint on satellite images leaves at different state leave, how to interpret a spectral curves. Which are dominant factors controlling leaf reflectance. How to construct vegetation indices and hot to interpret them (an example of NDVI (Normalised Difference Vegetation Index)).

✍ *Time required to complete this part of lesson: 25 min.*

✍ Practical part

Students will calculate NDVI index basing on MOD2 MODIS image for a given region using QGIS software. Later they will evaluate which land cover classes are the most photosynthetically active. To do so, they will use a land cover map and they will check values of NDVI for different types of land cover (global warming vs vegetation.docx).

Students will analyse changes in characteristics of growing seasons in various geographic regions for following years: 2000, 2005, 2010, 2015 and 2020; using NDVI ten days composites derived from MODIS satellite.

The class is divided into groups (6), each group has a designated geographical region:

1. Southeast Asia (e.g. China and India)
2. Central Africa (Tanzania and the Democratic Republic of the Congo)
3. Western and Central Europe (e.g. Germany and Poland)
4. North America (USA and Canada)
5. South America (Brazil and Chile)
6. Oceania (Australia and New Zealand)

Using QGIS software students will collect 5 annual series (every 10 days) of NDVI values for various points in a designated geographical region (global warming vs vegetation.docx). Later using Excel software they will calculate mean values for the area averaging values collected for points for each date. Next they will plot mean NDVI value on graphs (one graph per year). Using the graphs they will find the beginning and the end of growing season, will calculate its length, will find a maximum of NDVI index within the year, and establish the moment of maximum photosynthetic activity, they will also calculate the mean NDVI during the growing season. All these variables will be find for all years and the compared.

Time required to complete this part of lesson: 20min + 25 min.

✍ Summary of the lessons

Summary of results from all regions and their comparison. Individual groups present their conclusions regarding the changes in vegetation in the region in the period 2000 – 2020. They will discuss if trends in all regions were similar.

Time required to complete this part of lesson: 20 min.

Presentation Solutions:

Slide 33:

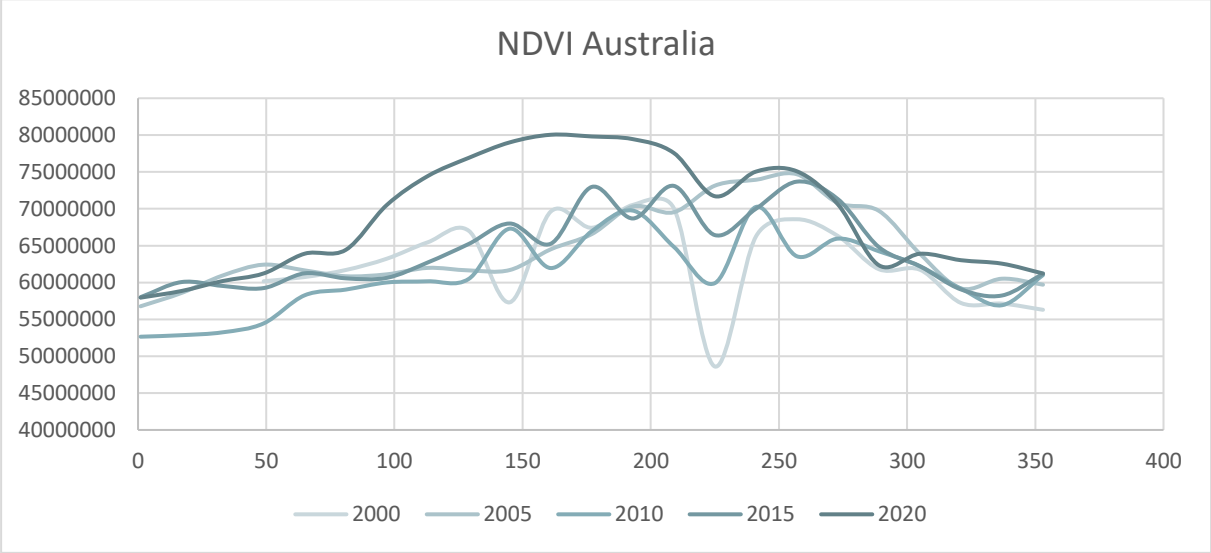
General conclusions:

- Year 2020 is different in almost all cases
- the increase of photosynthetic activity is visible
    - higher maximum value
    - longer period

- If it is a trend or just one exceptional year should be checked using longer or more dense time series

By regions:

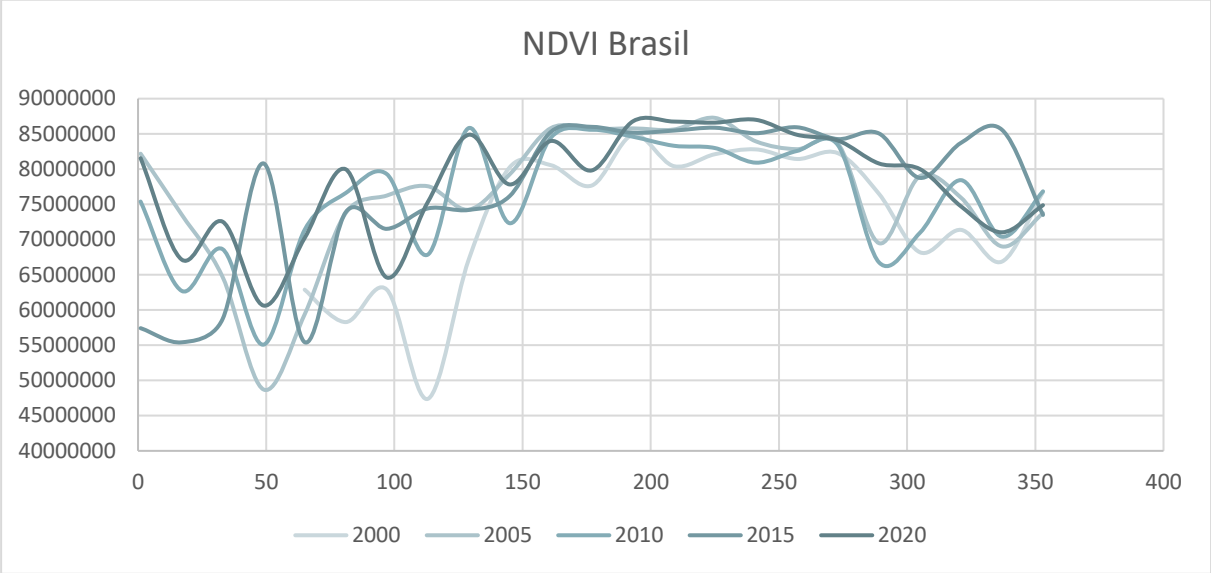
Australia:



	min	t(min)	max	t(max)	growing season
2000	48607500	225	70529000	193	whole year
2005	56778000	1	74690000	257	whole year
2010	52647000	1	70247500	241	whole year
2015	58011500	1	73688000	257	whole year
2020	57951000	1	80047000	209	whole year

- during all year the vegetation is photosynthetically active NDVI>0.4
- the vegetation decreases its activity in winter (in July for a very short time), and in summer from December to February
- the decrease of the activity in winter is smaller in 2020 than in 2000 (maybe it is connected to less sever winters)
- the general pattern of vegetation activity is the same for 2000, 2005, 2010 and 2015; in 2020 vegetation was much more active in autumn (the analysis of next years should be done to see if it is a singular case or a trend)
- the maximum NDVI values 0.8 in 2020 was at least 0.05 higher than in the rest of years and the maximum was reached in the mid-autumn and it was much high than the values in spring when the photosynthesis was the most active in the rest of the years

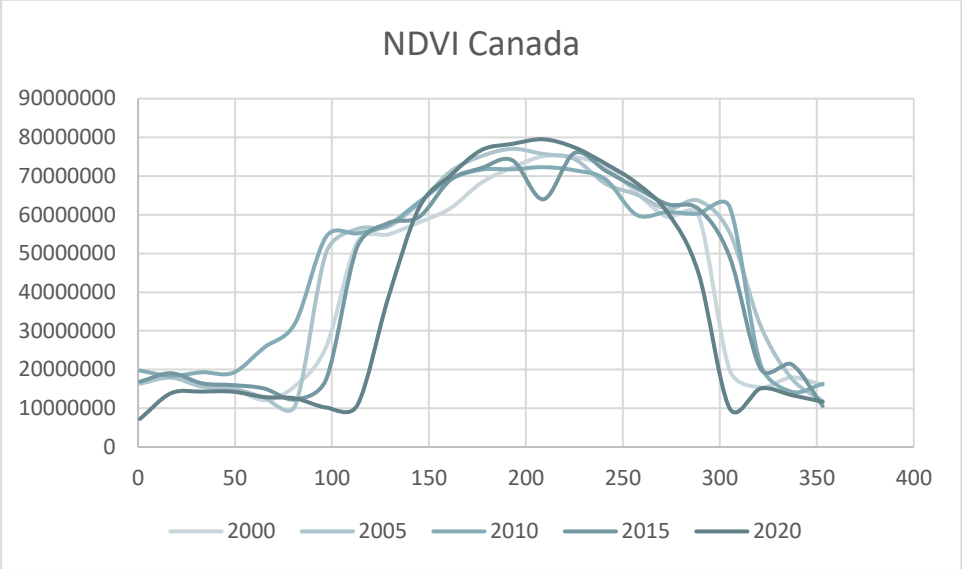
Brazil:



	min	t(min)	max	t(max)	growing season
2000	47378500	113	84861000	193	whole year
2005	48707500	49	87272500	225	whole year
2010	55085000	49	85823000	129	whole year
2015	55410000	17	85996000	177	whole year
2020	60619500	49	86998000	241	whole year

- during all year the vegetation is photosynthetically active NDVI>0.4
- a stable and very high vegetation activity (NDVI > 0.85) takes place from May to September
- the vegetation activity varies very much in the period from January to May (in April 2000 the decrease of the activity may be relate to very long period of presence of the La Niña phenomenon - 5 consecutive overlapping 3-month periods at or below the -0.5 anomaly for cold events and in contrary in February 2015 the increase of the photosynthetic activity connected to El Niño event - 5 consecutive overlapping 3-month periods at or above the +0.5 anomaly for warm)

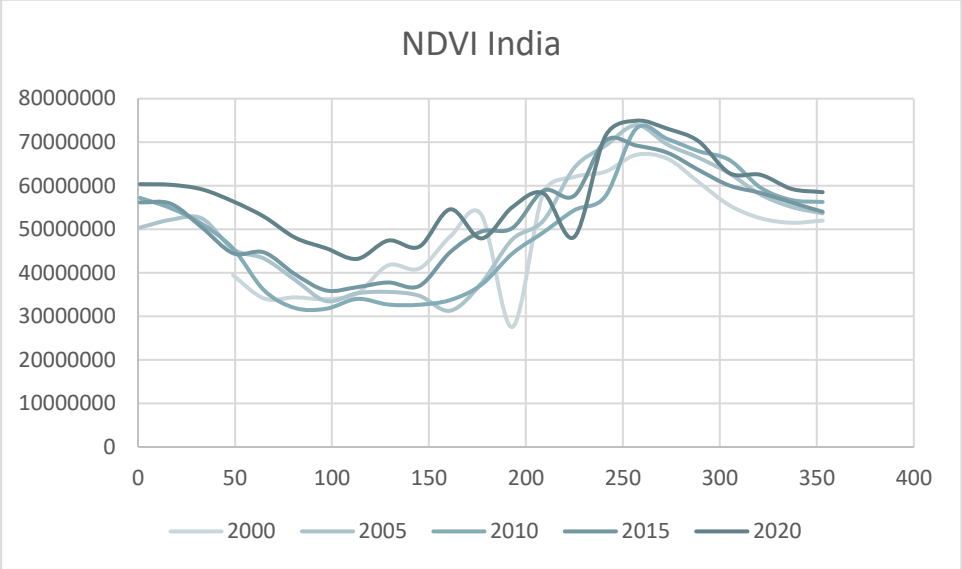
Canada:



	min	t(min)	max	t(max)	growing season
2000	12138000	65	75123500	209	176
2005	10678000	81	77035500	193	208
2010	14284000	337	72292500	209	208
2015	10609000	353	75952000	225	192
2020	7262500	1	79498000	209	144

- the maximum activity of vegetation occurs from May to September
- in years from 2000 to 2015 spring and autumn is clearly seen, with a little bit lower vegetation activity than in summer, in 2020 spring and autumn practically disappeared
- the length of vegetation season in 2020 is much shorter (around 50 days) than in previous years, (the analysis of next years should be done to see if it is a singular case or a trend)
- it seems that growing season becomes shorter

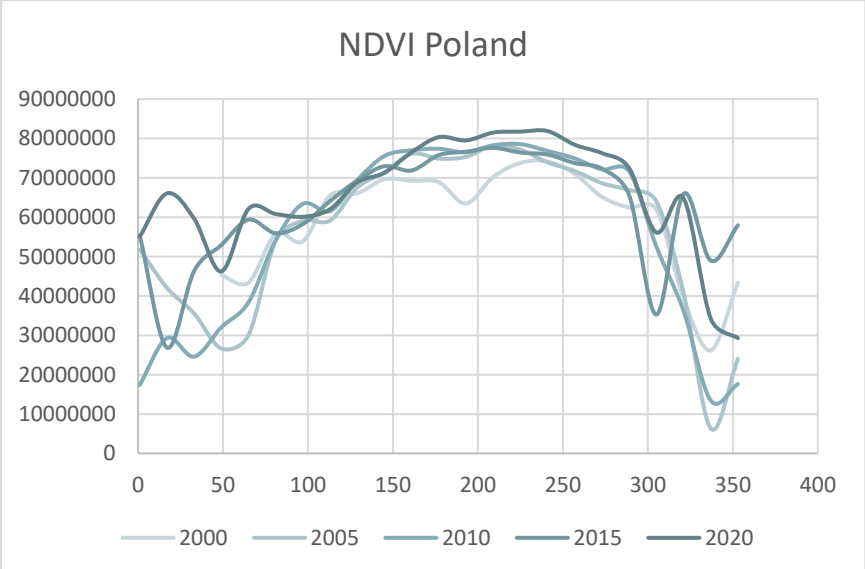
India:



	min	t(min)	max	t(max)	growing season
2000	27570500	193	67118000	257	224
2005	31305000	161	73933000	257	224
2010	31751000	97	73182000	257	208
2015	35946500	65	70350000	241	256
2020	43204000	113	73079500	273	whole year

- the trends in vegetation activity is the same in all years
- only in 2020 the photosynthesis was active during whole year (NDVI >0.4) in the rest of years the vegetation was not active in spring (longer observation is needed to confirm if it is trend or just an exceptional year)
- it seems that the growing season becomes longer

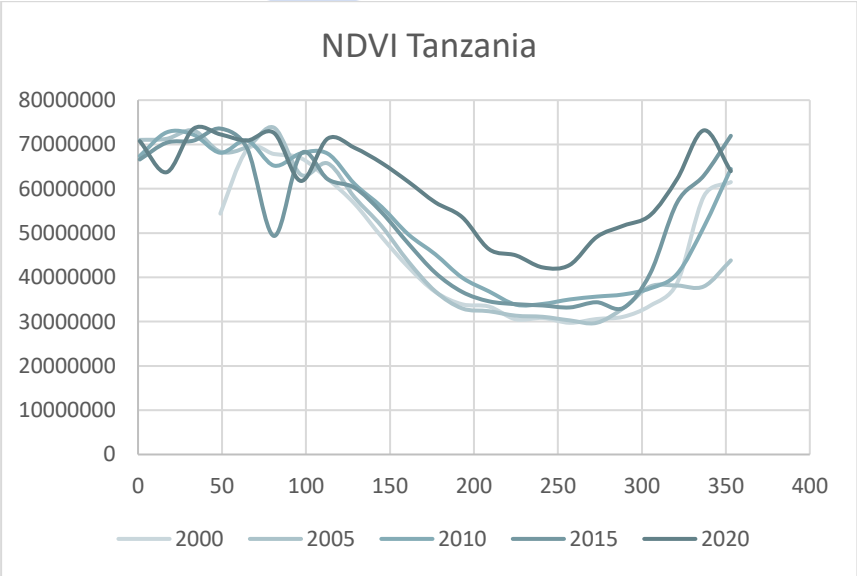
Poland:



	min	t(min)	max	t(max)	growing season
2000	26181000	337	74144500	241	256
2005	6353500	337	78233000	225	240
2010	13476500	337	78535000	225	224
2015	26887500	17	77593500	209	337
2020	29287000	353	81874000	241	320

- the trends in vegetation activity is the same in all years
- only in 2020 the photosynthesis was active during almost whole year, except December (NDVI >0.4) in the rest of years the vegetation was not active in winter (longer observation is needed to confirm if it is trend or just an exceptional year)

Tanzania:



	min	t(min)	max	t(max)	growing season
2000	29734000	257	68855000	241	209
2005	29719000	273	73771000	225	193
2010	33826500	225	72713000	225	241
2015	33092500	289	73577000	209	257
2020	42227500	241	73534000	241	whole year

- the trends in vegetation activity is the same in all years
- only in 2020 the photosynthesis was active during whole year (NDVI >0.4) in the rest of years the vegetation was not active from June to October (longer observation is needed to confirm if it is trend or just an exceptional year)
- it seems that the growing season becomes longer

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https://futurespaceproject.eu/