

### How does global warming influence on vegetation?

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### Climate change impacts on trees



(Menezes-Silva, et al. 2019)

#### Climate-related changes in:

- temperature,
- rainfall,
- nitrogen deposition
  - can affect tree physiology



#### **Temporal scale**

### Climate change impacts on forest ecosystems

Expected cascading effects indirect) (direct and



(Kramer, et al. 2020)

### Satellite images for vegetation monitoring



#### Land use and land cover

#### Cover

- foliage projective cover
- tree density
- coarse woody debris
- greenness
- vegetation health

#### Vegetation structure

- vertical forest structure
- above-ground biomass
- leaf area index
- basal area
- individual crowns and gap size

#### Vegetation chemistry and moisture

- foliar chemistry
- fraction of absorbed photosynthetically active radiation
- moisture content

#### Biodiversity

- individual species identification
- biodiversity

#### Disturbance

- detecting forest disturbance and recovery over long and multiple time periods
- fire scar mapping

### Photosynthesis



OXYGEN



the plant absorbs water (H<sub>2</sub>O) and mineral salts that are found in the soil through the roots

the leaves take carbon dioxide  $(CO_2)$  of the air through the small pores

the leaves trap energy from sunlight

the plant uses energy of sunlight to turn water (H2O) and carbon dioxide (CO<sub>2</sub>) into sugars and oxygen (O<sub>2</sub>)

the plant releases oxygen  $(O_2)$  into the air

 $C_6 H_{12} O$ 

GLUCOSE

the plant uses the sugars – glucose  $(C_{16}H_{12}O_6)$  - for growth

H<sub>2</sub>O

WATER

CO<sub>2</sub>

+

### MODIS



### Moderate Resolution Imaging Spectroradiometer

- MODIS satellites are viewing the entire Earth's surface every 1 to 2 days
- acquiring data in 36 spectral bands ranging in wavelength from 0.4  $\mu m$  to 14.4  $\mu m$
- varying spatial resolutions (2 bands at 250 m, 5 bands at 500 m and 29 bands at 1 km)
- operating from 1999 (global products avaiable from spring 2000)



#### We will use:

- MOD09A1 reflectance product to calculate vegetation indices
- MOD13A1 vegetation indices product to analyse changes in growing season characteristics in the period 2000-2020



# Leaf anatomy and processes which take place in State leaf have a footprint on satellite images



Interaction of electromagnetic wave with leaf: State reflection, absorption, transmission



Why are leaves green?

### **Reflectance of various** wavelength depends strongly on leaf state



### Spectral curves of leaves at different state



### Vegetation spectral curve – dominant factors Space controlling leaf reflectance



### **MODIS** bands and vegetation index



FUTURE



#### MAX = 1 intensive photosynthesis





### **Research questions**



- Has a phenological cycle changed from 2000 to 2020 (length of growing season, its intensity, its maximum period)?
- What could be the possible drivers of changes?



### Practice



- 1. To calculate NDVI using MODIS reflectance images (MOD09) and to compare the values of indices for different land covers
- 2. To analyse changes in photosynthesis cycle from 2000 to 2020 in different regions



### Instruction – part 1. Calculation of vegetation index NDVI

#### Opening software and data

#### 1. Open QGIS





2. Drag an image *"region\_date\_*multiband.tif"







![](_page_18_Figure_0.jpeg)

ression								Raster calculator
								This algorithm allows performing algebraic
ayers	C	perators						operations using raster layers.
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xpression								the minimum cell size of selected reference lay will be used. If the output CRS is not specified,
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Expression is valid								(based on 1), using the pattern layer_name@ number'. For instance, the first band from a lay named DEM will be referred as DEM@1.
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The NDVI layer will appear in your project. However due to erroneous value at the Edge of clouds it will be little visible. To make it visible do the following:

a) click right button of the mouse on NDVI layer and choose

![](_page_19_Figure_2.jpeg)

![](_page_19_Picture_3.jpeg)

.......

![](_page_19_Picture_4.jpeg)

![](_page_20_Picture_0.jpeg)

You will obtain a similar image.

White colour means that the photosynthesis within the area is very high, black that it is very low.

![](_page_20_Figure_3.jpeg)

![](_page_20_Picture_4.jpeg)

### Comparison of the values of NDVI for different land covers

![](_page_21_Picture_1.jpeg)

1. Drag *multiband* image to the top of the list

![](_page_21_Figure_3.jpeg)

![](_page_21_Picture_4.jpeg)

![](_page_22_Figure_0.jpeg)

Render

Temporal

Pyramids

Cimy

Contrast

enhancement

Stretch to MinMax

Ε

see better differences among different land covers

![](_page_23_Figure_0.jpeg)

#### Checking vegetation indices for different land cover and their interpretation

4. Choose *Feature Identification* tool and click on the image

Identification Results window will appear and Values of all layers

5. Change *View* to *Table* 

6. Click on different types of land cover and check NDVI values

7. Elaborate table with NDVI for different land cover discuss and draw conclusions about photosynthesis activity, where is the most/less intensive and why.

1       France_2020185       1       Band 1       464         2       France_2020185       2       Band 2       4437         3       France_2020185       3       Band 3       255         4       France_2020185       4       Band 4       689         5       France_2020185       5       Band 5       3842         6       France_2020185       6       Band 6       2186         7       France_2020185       7       Band 7       865         8       NDVI       1       Band 1       0.810651		Layer	FID	Attribute	Value
2       France_2020185       2       Band 2       4437         3       France_2020185       3       Band 3       255         4       France_2020185       4       Band 4       689         5       France_2020185       5       Band 5       3842         6       France_2020185       6       Band 6       2186         7       France_2020185       7       Band 7       865         8       NDVI       1       Band 1       0.810651	1	France_2020185	1	Band 1	464
3       France_2020185       3       Band 3       255         4       France_2020185       4       Band 4       689         5       France_2020185       5       Band 5       3842         6       France_2020185       6       Band 6       2186         7       France_2020185       7       Band 7       865         8       NDVI       1       Band 1       0.810651	2	France_2020185	2	Band 2	4437
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8 NDVI 1 Band 1 0.810651	7	France_2020185	7	Band 7	865
	8	NDVI	1	Band 1	0.810651
					~

![](_page_24_Picture_7.jpeg)

### Instruction – part 2. Analysis of changes in photosynthesis cycle from 2000 to 2020 in different regions

![](_page_25_Figure_1.jpeg)

![](_page_26_Picture_0.jpeg)

#### Extraction of NDVI values within growing season

![](_page_27_Picture_1.jpeg)

6. Remove all the layers except region\_sample\_points .shp. Select layers clicking on them and pressing *Crtl*. Press right button of the mouse and select *Remove Later ...* from the list

![](_page_27_Picture_3.jpeg)

![](_page_28_Picture_0.jpeg)

#### 7. Select all MOD13A1 files in the your region folder year 2020 and drag to the project

![](_page_28_Figure_2.jpeg)

## Preparation of tool for the automatic extraction of values from layers to point

![](_page_29_Picture_1.jpeg)

![](_page_29_Figure_2.jpeg)

New icon will appear 14. Press it to open the tool window\_\_\_\_

![](_page_29_Picture_4.jpeg)

🗯 Po	int Sampling Tool	×	]		rure POCE		
Gene	r containing sampling points:		15. Select point layer				
sam Laye HD HD	ple_points_reproject 's with fields/bands to get values from: 0F4_EOS:EOS_GRID:"MOD13A1.A2000305.h18v04.006.zo15139075558" : Band 1: 500m 16 days EVI (ra 0F4_EOS:EOS_GRID:"MOD13A1.A2000289.h18v04.006.201513908+516" : Band 1: 500m 16 days EVI (ra	16. Using Shift and mouse select all layers					
HD HD HD HD	F4_EOS:EOS_GRID:"MOD13A1.A2000273.h18v04.006.201513517555977: Band 4: 500m 16 days EVI (ras F4_EOS:EOS_GRID:"MOD13A1.A2000257.h18v04.006.2015139074748" : Band 1: 500m 15 days EVI (ras F4_EOS:EOS_GRID:"MOD13A1.A2000241.h18v04.006.2015138080613" : Band 1: 500m 16 days EVI (ras F4_EOS:EOS_GRID:"MOD13A1.A2000225.h18v04.006.2015138075440" : Band 1: 500m 16 days EVI (ras	ster) ster) ster)	17. Set output layer name, select c	sv forma	t		
Outp	ut point vector layer: :/edu/roslinnosc/France/2000/sample_points_2000.csv	Browse	18. Go to <i>fields</i> tab				
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			source	name			
19. Change th to the numbe digits before . 20.Press <i>OK</i>		1 HDF4_EOS:EOS_GRID:	209				
	9 Change the names of the fields from default	2 HDF4_EOS:EOS_GRID:"MOD13A1.A2000193.h18v04.006.2015138073706" : Band 1: 500m 16 days EVI 193					
	to the number of the day of the year (last 3	3 HDF4_EOS:EOS_GRID:"MOD13A1.A2000177.h18v04.006.2015138073717" : Band 1: 500m 16 days EVI 177					
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		5 HDF4_EOS:EOS_GRID:	MOD ISA I.A21:0145.h 8v04.006.2015137094735" : Band 1: 500m 16 days EVI	145			
	20  Press  OK	6 HDF4_EOS:EOS_GRID:"MOD13A1.A2000129.h18v04.006.2015137053027" : Band 1: 500m 16 days EVI 129					
	20.11C33 OK.	7 HDF4_EOS:EOS_GRID:"MOD13A1.A2000113.h18v04.006.2015137035129" : Band 1: 500m 16 days EVI 113					
	The file .csv will de obtained	8 HDF4_LOS.EOS_CRID:	MOD13A1.A2000097.h18v04.006.2015136040608" : Band 1: 500m 16 days EVI	HDF4_EOS:E	•		
		Status:	QK	ОК	Close		

#### Statistical analysis of NDVI values within growing season

![](_page_31_Picture_1.jpeg)

- 1. Open .csv file in excel
- 2. Order columns from the first to the last day of the year
- 3. Calculate mean value per day

4. Create a graph of changes of NDVI values during the year, find maximum and minimum values and when they take place, calculate numbers of day with NDVI > 0,4

5. Compare it for all years for your region

![](_page_31_Figure_7.jpeg)

### **Discussion and conclusions**

![](_page_32_Picture_1.jpeg)

- Individual groups present their conclusions regarding the changes in vegetation in the region in the period 2000 – 2020.
- They will discuss how different if growing season within areas
- If there are regional trends of changes? If yes, if they are similar for all regions?
- What factors influence in they opinion of changes
- What should be done to ensure that the concussions are correct?
  etc.