Lesson outline

Author/
Authors: **Edyta Woźniak**

Key words:
Global warming

Global Warming impact on Land Surface Temperature

Subjects:
geography

Topic: Global warming

Students' age: 15-19

Time: 🕓 2 lessons

LESSONS IDEA - Teacher's guide

The lesson 'Global Warming impact on Land Surface Temperature' is a 2nd part of a 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 Land Surface Temperature (LST) in different regions using satellite images. The analysis of LST trends will be done separately for 2 months of the year – January and July.

✍ Lesson objectives

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

✍ Results

- Students will know emissivity principles and the Stefan Boltzmann Equation
- Students will know how different kinds of land cover influence on LST
- Students will discover how land surface temperature has changes in various geographic zones in the period 2001-2021

ADDITIONAL MATERIALS:

- presentation global warming vs temperature.pptx
- 2 MODIS satellite images (MOD11C3 product), LST product in geo-tiff format 2001_July.tif 2021_July.tif
- regional sets of temperature data extracted from monthly mean values of LST (January and July) [month]_2001_2021_[region].xlsx and corresponding sets of xlxs files with solution for teachers + summary of solutions

- Software: QGIS, Excel

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

DESCRIPTION OF THE LESSON

✍ Theoretical part

Several ways of manipulation of real data will be shown to pupils to encourage them to think critically and be cautious while receiving information.

The raise of LST is one of the evidences of climate change. LST is derived from satellite images (in our case MODIS) using various emissivity bands converted in brightness temperature. Students will learn about emissivity principles, how to calculate brightness temperature using the Stefan Boltzmann Equation. As the influence of the atmosphere is significant while the LST is derived from satellite data as well as the type of land cover, students will also learn about effects of these factors on the LST.

✍ *Time required to complete this part of lesson: 40 min.*

✍ Practical part

Students will analyse changes in LST in various geographic regions for two seasons of year for the period 2001-2021 using LST product derived from MODIS satellite.

The class is divided into groups (10), each group has a designated geographical region and different land cover:

1. Glacier_Greenland
2. Glacier_Antarctica
3. Desert_Sahara
4. Desert_Gobi
5. Tundra_Canada
6. Taiga_Siberia
7. Agriculture_Poland
8. Savannah_Tanzania
9. Tropical forests_Amazonia
10. Meditrranean_Australia

Using Excel software they will set a trend line. They will analyse if trend are equal for winter and summer season (be careful with hemispheres).

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

✍ Summary of the lessons

Summary of results from all regions and their comparison. Individual groups present their conclusions regarding the trend of LST in the region in the period 2001 – 2021. They will discuss if trends in all regions were similar and about what can influence obtained results.

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

Presentation Solutions:

Slide 2:

- The graph is not significant because shows too short period to talk about climate. As a standard, we calculate climate statistics over a period of 30 years, only such a long interval allows us to obtain statistically significant results. In the second graph when a period long enough is shown, there is a clear correlation between CO2 emissions and the global temperature anomalies.
- 1968-1976; 1977-1985; 1981-1986; 1987-1995. It is easy to manipulate using real data, just showing not sufficiently long period in relations to the phenomenon which we want to show.

Slide 3:

- Showing only one region is a kind of manipulation, this time in the spatial sense. Differences in LST in NW North America, S Africa, Central N Syberia, N Europe, central Australia deny global warming, almost whole South America, central and NE Asia, N Australia confirm it. Showing whole word we can see a real picture. Also it is necessary to indicate that comparison of 2 years even if they are separated in time it is not enough because the trend analysis is necessary to confirm or not the thesis of global Warming.

Slide 10:

- W North America, whole South America, N Europe, central Asia, N Australia confirm global warming. NE and SE North America, NE Asia deny it. Also it is necessary to indicate that comparison of 2 years even if they are separated in time it is not enough because the trend analysis is necessary to confirm or not the thesis of global Warming.

Slide 15:

<u>General conclusions driven from students' work:</u>

- 12 out of 20 all cases have positive trends it means the positive trends prevail
- The world trend is more visible in January – 7 out of 10 case present the positive trend.

landcover	January	July
Glacier_Greenland	0,1032	0,0081
Glacier_Antarctica	-0,0535	0,0084
Desert_Sahara	0,0391	0,021
Desert_Gobi	0,0549	0,012
Tundra_Canada	0,0914	-0,0273
Taiga_Siberia	-0,0219	-0,0496
Agriculture_Poland	0,0396	-0,1062
Savannah_Tanzania	0,0235	-0,0306
Tropical forests_Amazonia	-0,0231	0,0273
Meditrranean_Australia	0,1147	-0,0107

- The raise of LST occurs mainly in winter, the decrease in summer

landcover	Winter	Summer
Glacier_Greenland	0,1032	0,0081
Tundra_Canada	0,0914	-0,0273

Taiga_Siberia	-0,0219	-0,0496
Agriculture_Poland	0,0396	-0,1062
Desert_Gobi	0,0549	0,012
Desert_Sahara	0,0391	0,021
Glacier_Antarctica	0,0084	-0,0535
Meditrranean_Australia	-0,0107	0,1147
Savannah_Tanzania	-0,0306	0,0235
Tropical forests_Amazonia	0,0273	-0,0231

- The January became hotter in both hemispheres

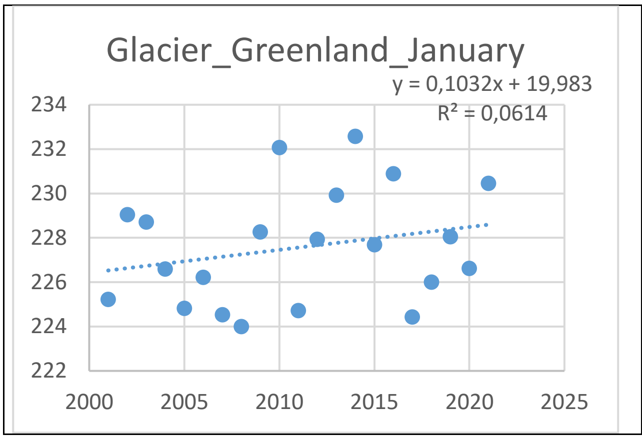
Northern hemisphere	January	July	Southern hemisphere	January	July
Glacier_Greenland	0.1032	0.0081	Glacier_Antarctica	-0,0535	0,0084
Tundra_Canada	0.0914	-0.0273	Meditrranean_Australia	0,1147	-0,0107
Taiga_Siberia	-0.0219	-0.0496	Savannah_Tanzania	0,0235	-0,0306
Agriculture_Poland	0.0396	-0.1062	Tropical forests_Amazonia	-0,0231	0,0273
Desert_Sahara	0.0391	0.021			

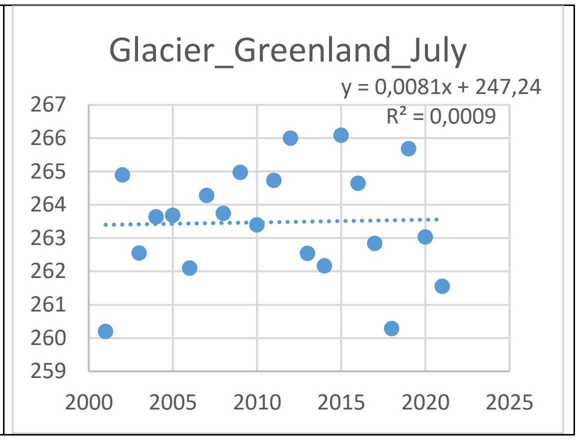
- The most visible positive trend (increase of LST) is visible for surfaces not covered by vegetation for deserts (all cases), glaciers (3 out of 4 cases), more visible in January.

- The trends in northern hemisphere seem to be better defined than in the southern one. It can be connected with the land/ocean proportion and differences in temperature exchange
- If we take into account all data both hemispheres are hotter but the trend is stronger for the northern one
- Longer time series is needed to confirm conclusions
    - in one case one record influenced on general trend. In January in Tanzania abnormal value had been obtained in 2006 and decided about negative trend, but when we remove this value a trend becomes positive;
    - maximum and minimum in time series very often is very close one to other

By type of land cover:

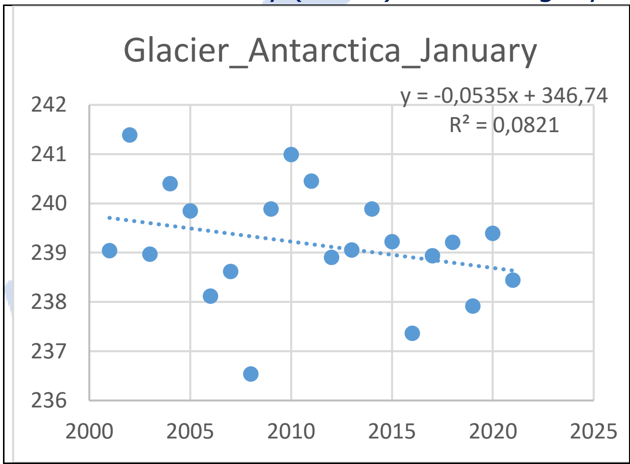
- **Glaciers**:
  Greenland
    - LST increased in both January and Jul
    - Winter time is much warmer that it used to be. In January, the maximum was detected in 2014 and the minimum in 2008.
    - In summer the positive trend (increase of temperature) is less visible
    - In July: maximum - 2015, minimum – 2001.

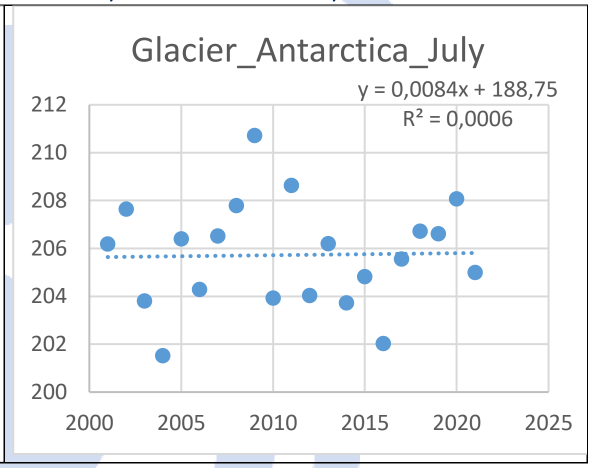




<u>Antarctica</u>

- In January (summer) the LST clearly decreased; minimum: 2008, maximum: 2002
- In July (winter) the LST slightly increased; minimum: 2004, maximum: 2009

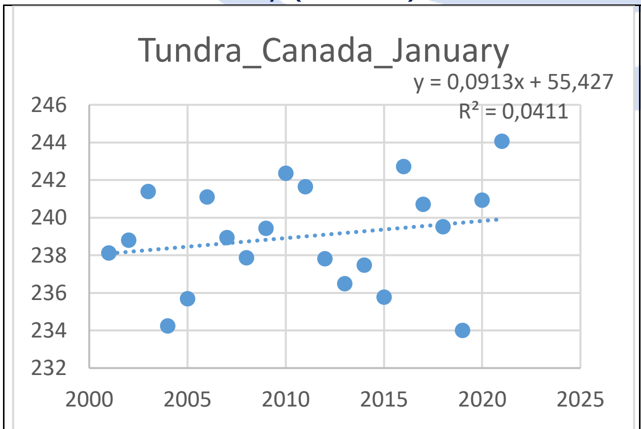


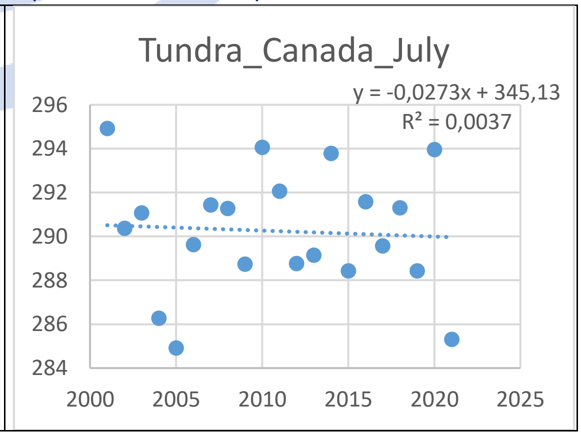


– **Tundra:**

<u>Canada</u>

- In January (winter) the temperature increased; minimum: 2020, maximum 2021.
- In July (summer) the LST decreased; minimum: 2005, maximum 2001

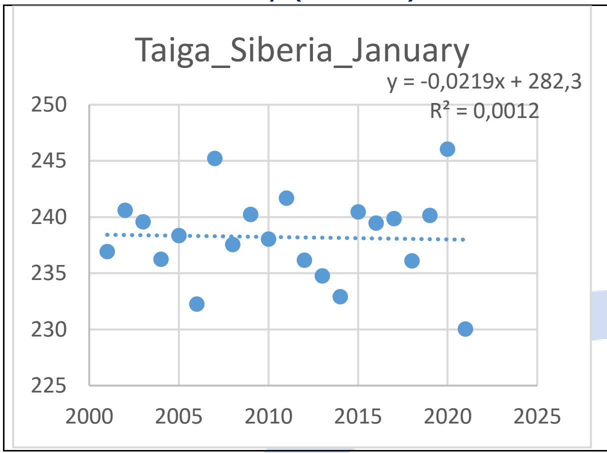


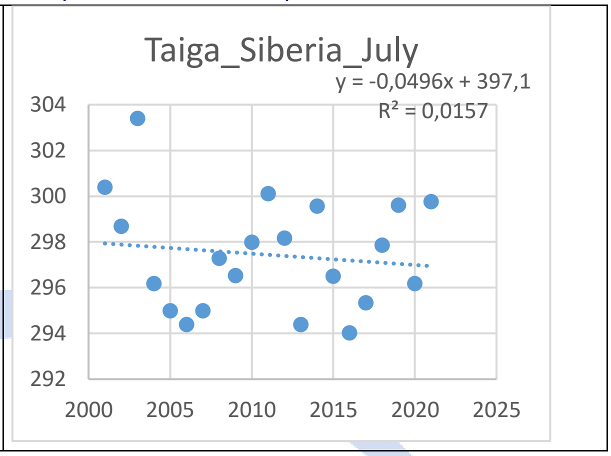


– **Tajga**:

Syberia

- In January (winter) the temperature decreased; minimum: 2020, maximum 2021.
- In July (summer) the LST decreased; minimum: 2003, maximum 2016

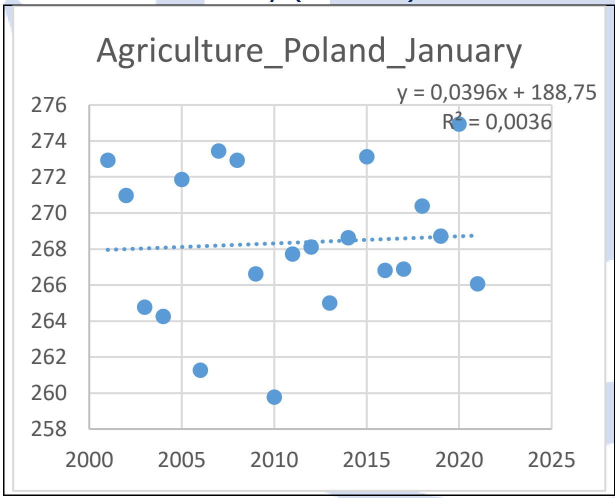


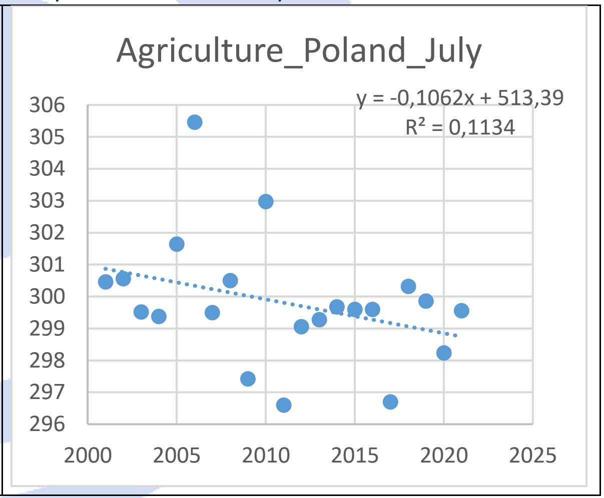


- **Agriculture**:

Poland

- The anomalies in the dataset were not found.
- In January (winter) the temperature increased; minimum: 2010, maximum 2020.
- In July (summer) the LST decreased; minimum: 2011, maximum 2006

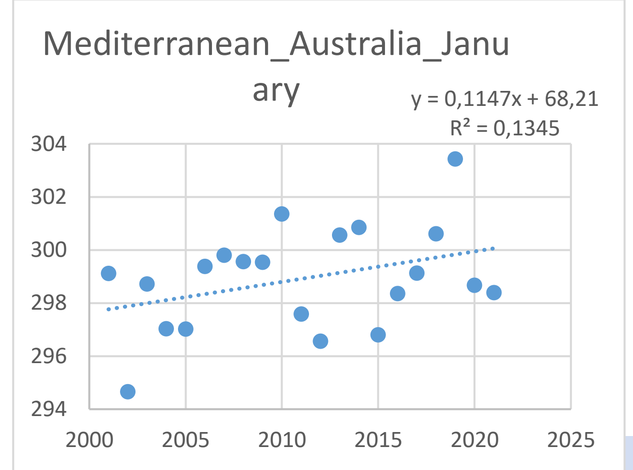


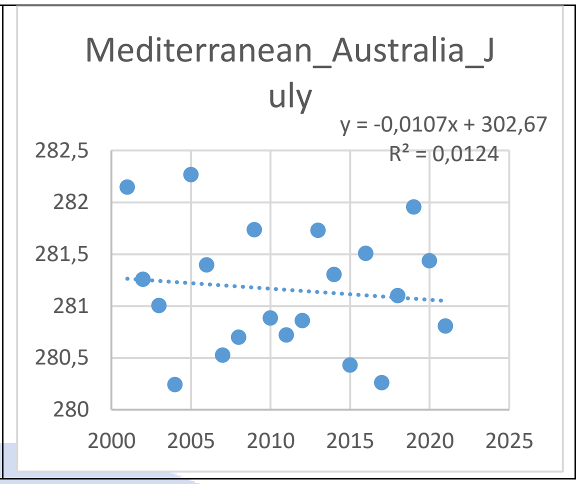


- **Mediterranean**:

Australia

- The anomalies in the dataset were not found.
- In January (summer) the LST clearly increased; minimum: 2002, maximum 2019.
- In July (winter) the LST decreased; minimum: 2004, maximum 2005

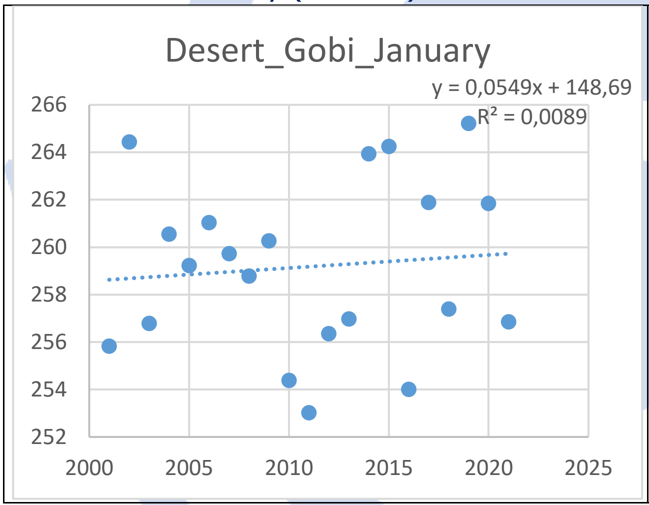


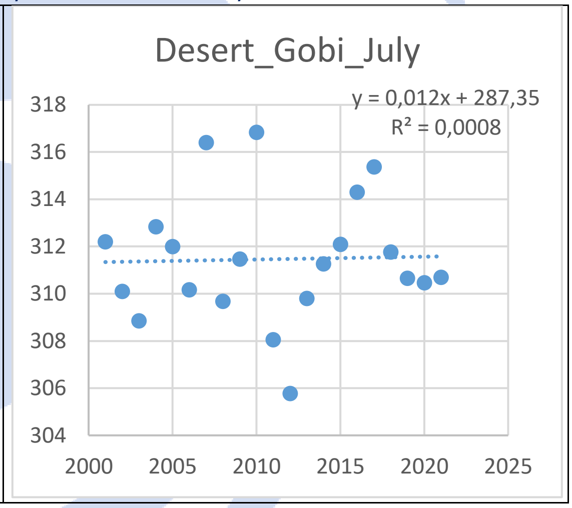


- **Desert**:

  Gobi

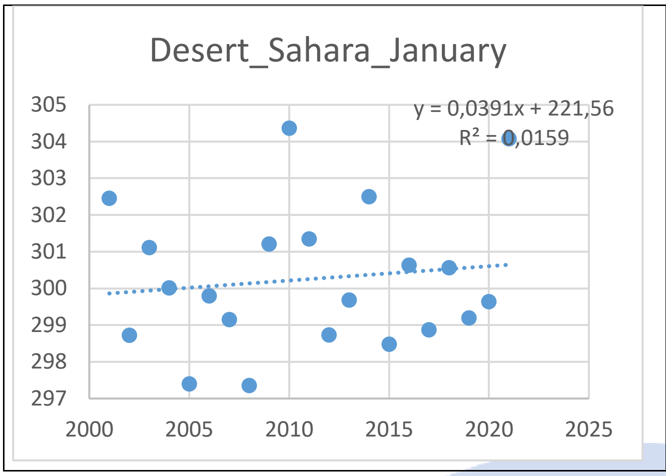
  - The anomalies in the dataset were not found.
  - In January (winter) the LST increased; minimum: 2011, maximum 2019.
  - In July (summer) the LST increased; minimum: 2012, maximum 2010

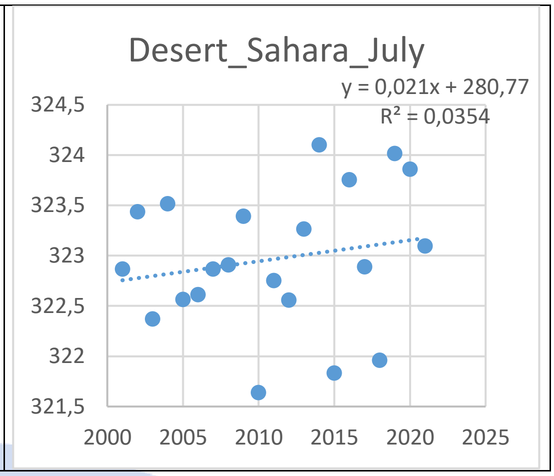




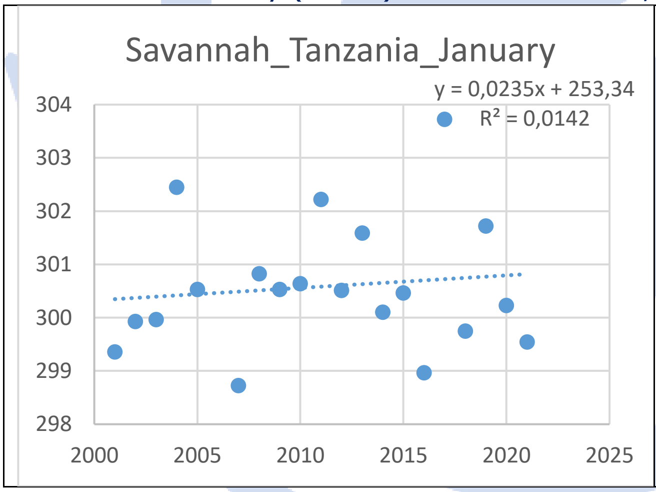
  Sahara

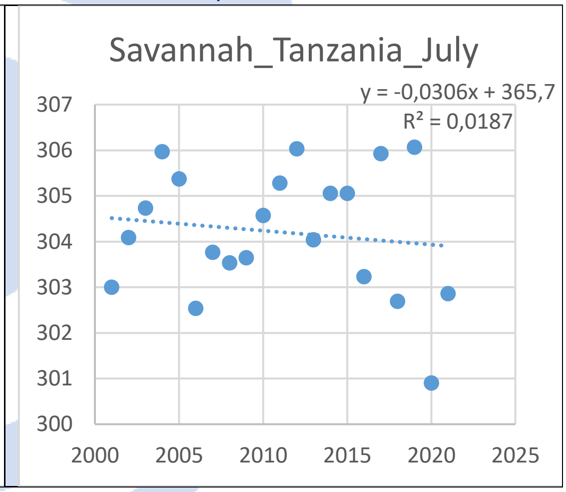
  - The anomalies in the dataset were not found.
  - In January (winter) the LST increased; minimum: 2005, maximum 2010.
  - In July (summer) the LST increased; minimum: 2010, maximum 2014



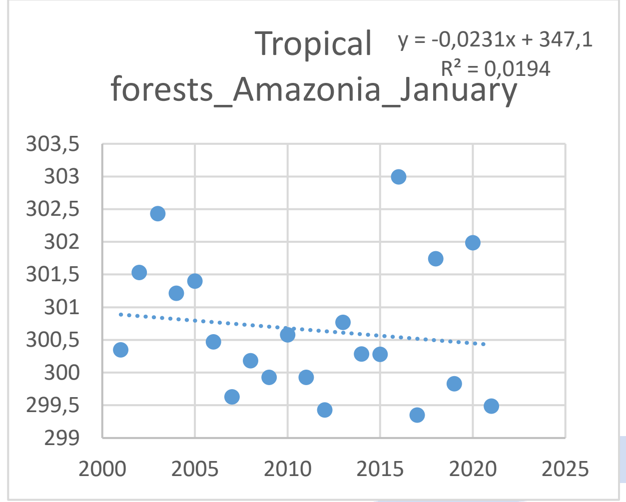


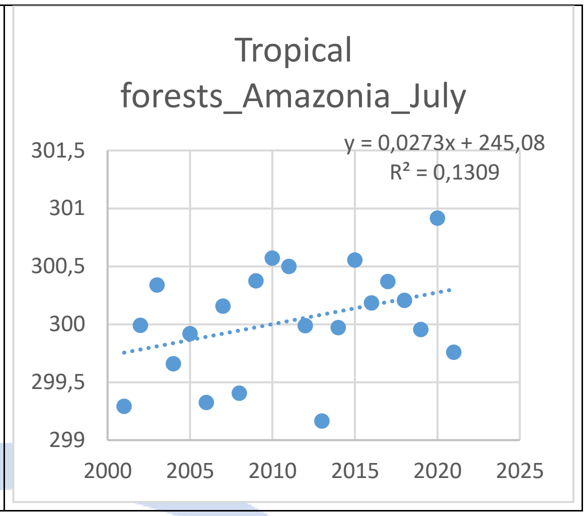
– **Savannah**:
  <u>Tanzania</u>
  - In January in Tanzania abnormal value occurred in 2006. This value decides about negative trend, when we remove this value a trend becomes positive. This anomaly is probably related to forest fires
  - In January (summer) the LST decreased; minimum: 2007, maximum 2017 (2006).
  - In July (winter) the LST decreased; minimum: 2019, maximum 2020





– **Tropical forest**:
  <u>Amazonia</u>
  - The anomalies in the dataset were not found.
  - In January (summer) the LST decreased; minimum: 2017, maximum 2016.
  - In July (winter) the LST increased; minimum: 2013, maximum 2020





Educational material prepared as part of the FUTURE SPACE project (grant no. 2019-1-PL01-KA201-065434), co-financed by the European Union in the ERASMUS+ programme

 https://futurespaceproject.eu/