Land Degradation Neutrality in the Tula region

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Abstract. The article assesses the Land Degradation Neutrality (LDN), taking into account the specifics of Russian regions (on the example of the Tula region). For the assessment of the used software module "Trends.Earth", remote sensing data and statistical materials in the public domain. About 44.70% of the territory of the Tula region by 2015 had deteriorated its characteristics, compared with 2000. The LDN values can be specified taking into account the specifics of the Russian regions. The article shows that the indicators of the LDN concept need serious adaptation, taking into account the peculiarities of soils and lands in Russia.

1. Introduction

Sustainable Development Goals (SDGs) were formally adopted by the UN General Assembly. The fifteenth global objective includes the aim of 15.3 is aimed at the conservation and prevention of land degradation and soils [1].

The following indicators are used as global indicators for monitoring the state of LDN: land productivity, carbon stocks and land cover [2].

Many countries use data provided by the United Nations Convention to Combat Desertification's. This is because some countries do not have reliable statistical information. At the same time, LDN targets can be checked and adjusted taking into account national databases. [3] Scientists around the world are investigating the integration of LDN at the level of specific states in particular for Madagascar and Italy this is done in the work of [4].

The main problem of implementing the LDN concept is that the results obtained within the framework of the general methodology do not agree well with the data of specific countries, in particular Russia [5].

LDN is a living concept that will evolve and adapt as it is applied and new data is accumulated [6]. Therefore, conducting an LDN assessment for different countries and regions is an urgent task.

2. Materials and methods

Within the framework of achieving sustainable development of territories, the UN approved the indicator of sustainable land status: "the share of degraded land from their total area". The calculation of this indicator is based on 3 sub-indicators:

- Land cover status and change;
- Land productivity;
Soil organic carbon reserves.

The calculation of the LDN indicators was carried out in the QGIS 3.10.11 program using the calculation module “Trends.Earth”. The module includes information from many international databases, as well as materials from remote sensing of the Earth. The methodology of calculations and construction of cartograms is described in detail in [7].

The calculation of the "land cover" indicator is based on the transition of land from one type of economic use to another. In this article, the calculation is based on the standard the land cover/land use change matrix for the 6 classes (30 possible transitions) [8]. It was also calculated using matrix, taking into account the peculiarities of land use in the territory of the Tula region.

The indicator "land productivity" was compared with the assessment of overgrowth of agricultural land according to [9].

The calculation of the "soil organic carbon" indicator was carried out according to the standard method. The assessment of the humus content in the districts of the Tula region was carried out using regional statistical data from [10].

3. Results
The results of calculating LDN according to the standard method are presented in table 1. The areas of degraded and stable land were divided approximately equally (about 45%). Land area improved has a much smaller area.

| Indicator                  | Area (sq km) | Percent of total land area |
|----------------------------|--------------|----------------------------|
| Total land area            | 25434.3      | 100%                       |
| Land area improved         | 2435.4       | 9.58%                      |
| Land area stable           | 11600.1      | 45.61%                     |
| Land area degraded         | 22368.4      | 44.70%                     |
| Land area with no data     | 30.4         | 0.12%                      |

Cartograms of the "land cover" indicator are shown in figure 1. In figure 1A, the assessment of land transitions was carried out according to the standard method. In figure 1B, the calculation was carried out taking into account the specifics of land use in the Tula region (overgrowth of any land was assessed as degradation). It can be seen that all the territories that were evaluated as improved (green) according to the standard methodology in the version adapted for the Tula region became degraded (red). Most of the territory is characterized by a stable state, that is, there was no change of land use in the period from 2000 to 2015.

Figure 2 shows two approaches to assessing the productivity of land in the Tula region. Even a visual comparison of cartograms shows that the land that according to the LDN method is characterized by stable and increasing productivity in fact has not been used in agriculture for more than twenty years. Areas in the south of the Tula region that are actively used in agriculture according to the standard LDN method are estimated as declining and early signs of decline.

Figure 3 shows the content of humus and organic matter in the soils of the region. Comparison of cartograms shows a general trend of increasing the content of humus and organic matter in the southern part of the Tula region.
Figure 1. Cartograms for assessing the degradation of the territory of the Tula region according to the indicator “change in vegetation cover” A: according to the standard LDN method, B: according to the adapted LDN method.

Figure 2. Cartograms of the state of vegetation cover of the Tula region. A: Land productivity according to the standard LDN method, B: data on unused agricultural land from [9].

Figure 3. The content of humus and organic matter in the soils of the Tula region A: the content of humus according to regional statistics B: the content of organic carbon according to the standard LDN method.
4. Discussion

The results obtained allow us to identify a number of imperfections in the LDN methodology. In the standard assessment methodology, the transition of "agricultural land" and "settlements" to "forests" is assessed as a positive phenomenon. In our opinion, these transitions should be evaluated as negative phenomena that lead to the degradation of the territory. Agricultural land is a natural and anthropogenic object. Man has adapted it for his own purposes. This object performs a unique set of ecosystem functions. [11] Therefore, the overgrowth of this object leads to the loss of unique ecosystem services that have been created for hundreds of years. People migrate from economically unviable villages in a major Metropolitan area. As a result of this process, rural settlements become empty and overgrown with weeds, and then trees and shrubs. Because these lands are not involved in agriculture and there is a decrease in the quality of life in rural areas of the Russian regions, this transition, in our opinion, should be assessed as a negative phenomenon.

The assessment of land productivity in the standard methodology is carried out using remote sensing data. This does not take into account the actual state of the land. That is, if some areas of land are increasingly overgrown with weeds and tree-shrub vegetation from year to year, in accordance with the LDN methodology, "improvements" will be recorded in this area. In our opinion, the results of these assessments should be adjusted to take into account the data of regional surveys of the state of the territory. Monitoring of the state of agricultural land is carried out by the Ministry of Agriculture of the Russian Federation. The results of monitoring should be taken into account when assessing land productivity.

Russia has historically developed approaches to assessing the state of soils based on the content of humus. The use of the assessment of carbon reserves in the soil column complicates the possibility of using the results of long-term monitoring of the humus content in the soil. Agrochemical services carry out this monitoring. Comparison of cartograms makes it possible to identify general trends in the accumulation of organic matter and humus in the south of the Tula region, but it is currently not possible to make a more detailed comparison.

5. Conclusion

The assessment of the territory of the Tula region according to the LDN methodology showed that in the period from 2000 to 2015, 44.70% of the region's territory was degraded. The analysis shows that the actual area of degradation may be even higher, since such negative phenomena as overgrowth of tree-shrub and weed vegetation on the territory of agricultural lands and settlements occur on the territory of the Tula region. Due to some peculiarities in the method of calculating LDN, these negative phenomena are perceived as improvements in the state of the territory. Therefore, the method of calculating LDN for Russian regions needs to be adapted taking into account the specifics of land use and soil properties. To evaluate the "land cover" indicator, it is necessary to develop a specific Russian adapted matrix of land transition between land uses.

For an objective assessment of land productivity, its results should be checked and corrected according to surveys of agrochemical services of the Ministry of Agriculture of the Russian Federation. In Russia, the state of soils is assessed by the content of humus, and not by the content of organic carbon. It is quite difficult to compare the results of official statistics and the results of the LDN assessment. Therefore, an urgent task is to develop approaches to optimize the LDN calculation methodology, taking into account the peculiarities of Russian regions.

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