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PROCEEDINGS

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UST BIOSPHERE TECHNOLOGIES FOR SOLVING GLOBAL ENVIRONMENTAL PROBLEMS

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ABSTRACT

The solution of such global environmental problems as climate change, waste accumulation, land degradation is possible using new biospheric technologies such as second-level string transport and the concept of a linear city. Unitsky's string transport allows not only to solve any problems of cargo and passenger transportation, but is also the most environmentally friendly and safest of the existing transport systems, aimed at preserving the environment and climate. The concept of a linear city offers options for solving urgent urban problems of air pollution, waste disposal and land degradation as a result of zoning.
Keywords: String transport, linear city, rail electric vehicles, unimobile, KFH «Unisky»

1. INTRODUCTION

To achieve the goals of sustainable development of civilization, significant efforts should be made due to the huge inertia of the natural resource-intensive trends of several countries (export-raw material model of the economy), which in turn will lead to a decrease in the anthropogenic load on the climate. An important feature of such changes will be the ecological sustainability of the environment. Issues that need to be urgently solved is: depleting valuable natural resources for temporary economic growth; serious impact of polluted environment on human health; natural resource orientation of exports; accumulation of hard-to-recycle waste production. To solve them, it is necessary to create conditions for the development of science-intensive industries and fundamentally new technologies, primarily in system-forming industries such as transport, industrial and civil infrastructure, energetics, agriculture.

With the aim of further technological development and conservation of natural resources, UST Inc. (Minsk, Republic of Belarus) offers a comprehensive solution that combines biosphere technologies and the transport industry: transport infrastructure complexes of the "second level"; Unitsky String Transport (uST); design-construction part (linear uCity cities, including elements of biotechnology); organic agriculture.

A developed transport infrastructure largely determines the investment potential of countries (regions) and is one of the most important factors that stimulates the economy, trade, development and implementation of innovative technologies, and increases welfare in general. However, already at the stage of construction of traditional roads and railways, negative aspects appear with significantly harm the environment. For example, when natural soils are covered with an artificial roadway, the natural living cover is transformed into an artificial dead surface, which leads to the destruction of growing plants, changes in the relief and migration routes of wild animals. Also indurated (by 10% in comparison with the natural occurrence of soil) earthen embankment of a traditional road becomes a man-made low-pressure dam. Compaction of the productive soils and their replacement by earthen embankments of roads change natural groundwater and surface water flows, which leads to swamping of the adjacent territories on the one side and drying out on the other. These factors increase natural fluxes of major greenhouse gases, which, together with vehicle exhaust gases, become a critical climate burden.

Unlike traditional transport solutions, in which advanced environmental developments must be integrated and have to adapt to existing features, UST complexes are initially developed considering all current world requirements (Unitsky, Tsyrlin, (2020). This transport system is a string-rail track structure on supports, along which unmanned rail electric vehicles (named unimobile) move (Fig. 1), which, due to the simplicity of their design (the absence of massive drives, powerful frames, heavy undercarriages and wheelsets), are characterized by low consumption of structural materials, excellent aerodynamics, high energy efficiency and do not require significant costs for their production.

Figure1. Different types of rolling stock uST (EcoTechnoPark (Marjina Gorka town, Republic of Belarus, 2020)

Due to low land acquisition, reduced resource intensity of preliminary stressing of the rail-string transport overpasses, low power consumption and simplified integration with communication systems, uST already at this stage allows to reduce the environmental load compared to traditional modes of transport. Another significant advantage is the preservation of the natural soil cover, on which it is possible to develop the associated infrastructure and use it for agriculture. As a result, one of the effective options for using land cover to reduce greenhouse gas emissions is to plant crops under the "second level" road (Fig. 2), which in principle cannot be done under roads built on the surface of the earth – at the "first level".

Figure 2. Land use option under the rail-string transport overpass

MATERIAL AND METHODS

In particular, the effect of reducing emissions of the main greenhouse gases was calculated using the example of tuberous sunflower (Helianthus tuberosus L.), as one of the options for introduced agricultural crops. To study the effect of growing Helianthus tuberosus L. on greenhouse gas fluxes, as a process of reducing the negative impact on the climate, preference was given to the chamber method as the most efficient and easy to implement, which allows localizing the object under study as a source of gases exchange and accurately measuring CO2, CH4 and N2O fluxes. In March 2020, a measuring platform was equipped by soil frames (Fig. 3), on which the fluxes of CO2, CH4 and N2O were measured using emission chambers (dark and transparent).

a

b

Figure 3. Measuring plot, KFH «Unisky» (a –soil frames, b – transparent chamber)

Carbon dioxide was determined in real time using an infrared gas analyzer LI-820 (LI-COR), gas samples of methane and N2O were determined on a gas chromatograph with electron capture (ECD) and flame ionization (FID) detectors. The chromatograph was calibrated according to gas standards at the beginning and after 12 samples. The infrared gas analyzer was calibrated to gas standards before each measurement company.

CO2 measurements were conducted on clear days, from dawn (minimum PAR value) to the peak of PAR value at 12–2 pm. The concentration of CO2 in the chamber was recorded at intervals of 5 seconds; also, every 5 seconds, time, temperature inside and outside the chamber, PAR, and the serial number of the measurement were automatically recorded. The exposure time of each measurement depended on the flow rate, but did not exceed 10 minutes, since after this time the equilibrium concentration of CO2 is established in the chamber and the flow estimate is distorted. For each measurement stable conditions were respected. (temperature amplitude inside the chamber within 1.5°C, PAR dynamics - no more than 10%).

Measuring the fluxes of methane and nitrous oxide, air samples were taken at regular intervals into pre-vacuum sealed flasks (60 ml). For one measurement, 5 samples were taken with an interval of 5 minutes. The flow rates of CO2, CH4, and N2O were calculated according to the ideal gas law, based on the changes in concentration with time in the chamber. Methane and nitrous oxide fluxes and their statistical processing were carried out in the R© software environment using the Flux and CaTools package. Processing with these packets eliminated interference due to turbulence and pressure fluctuations caused by the chamber installation, as well as from an increase in saturation and microclimatic effects from covering the site with the chamber.

RESULTS AND DISCUSSION

The measurements lasted for 5 months (from May to September), while the fluxes of the main greenhouse gases in the other months were conditionally assumed to be zero. To calculate the annual dynamics of the CO2 flux, all monthly measurements of the carbon dioxide concentration from each soil frame were considered. The results of measurements showed that CO2 emission prevailed in May (0.8 t/ha per year), in June there was a significant absorption of carbon dioxide (−4.4 t/ha per year), which peaked in July (−5.9 t/ha per year) and began to gradually decrease to -5.6 t/ha per year in August and -5.1 t/ha per year in September.

From May to September, methane emissions from the studied sites (Table 1) were insignificant.

Table 1. Site T1 (07.06.2020) CO2, CH4 и N2O concentration

nr	CO_2ppm	N_2Oppb	CH_4ppb	hour	plot_id	t_air	tsoil_2	ts_5	ts_10	vol	area
1	448,65	319,03	2034,49	12:33:00	T1_I	28	22,3	18,2	18,2	0,234	0,49
2	566,10	317,69	2030,88	12:38:00	T1_I	28	22,3	18,2	18,2	0,234	0,49
3	731,46	314,29	2024,48	12:43:00	T1_I	28	22,3	18,2	18,2	0,234	0,49
4	863,85	301,44	2018,75	12:48:00	T1_I	28	22,3	18,2	18,2	0,234	0,49
5	985,67	316,34	2007,21	12:53:00	T1_I	28	22,3	18,2	18,2	0,234	0,49
6	432,99	310,77	2015,67	12:33:40	T1_II	28	22,3	18,2	18,2	0,234	0,49
7	521,99	305,25	1954,40	12:38:40	T1_II	28	22,3	18,2	18,2	0,234	0,49
8	645,18	319,13	2024,56	12:43:40	T1_II	28	22,3	18,2	18,2	0,234	0,49
9	774,12	315,68	2015,03	12:48:40	T1_II	28	22,3	18,2	18,2	0,234	0,49
10	871,66	320,01	2035,08	12:53:40	T1_II	28	22,3	18,2	18,2	0,234	0,49
11	445,91	325,27	2045,79	12:34:10	T1_III	28	22,3	18,2	18,2	0,234	0,49
12	547,84	315,69	2034,30	12:39:10	T1_III	28	22,3	18,2	18,2	0,234	0,49
13	689,74	318,61	2019,54	12:44:10	T1_III	28	22,3	18,2	18,2	0,234	0,49
14	786,01	318,87	2024,52	12:49:10	T1_III	28	22,3	18,2	18,2	0,234	0,49
15	915,06	317,74	2020,67	12:54:10	T1_III	28	22,3	18,2	18,2	0,234	0,49

The results obtained is explained by the fact that these sites were subjected to human impact and, as a result, the soil became more saturated with oxygen, as a result of which the dominance of methane oxidation turned this area into insignificant methane runoff (Fig. 4).

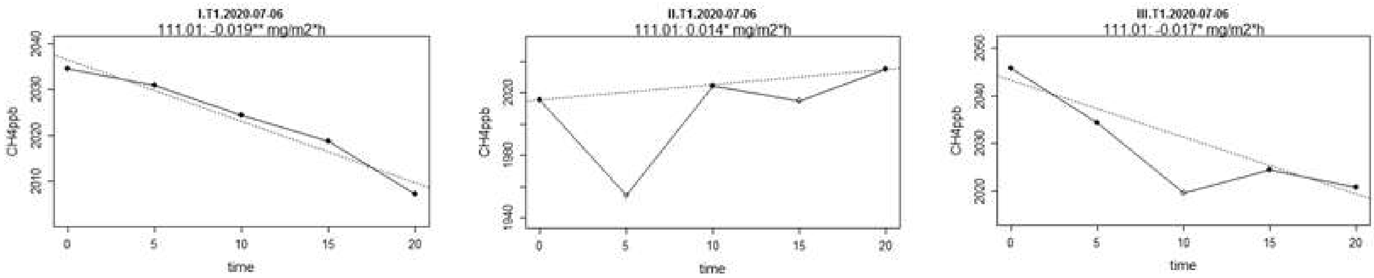

Figure 4. Methane emission 07.06.2020

Given the low quantitative values of natural nitrous oxide emissions, the timing of the study was chosen to coincide with the conditions (Burlo et al., 2016) under which the maximum flux of this greenhouse gas is possible (after sharp stable positive temperature and high humidity). However, N2O fluxes at the studied sites were insignificant (Fig. 5).

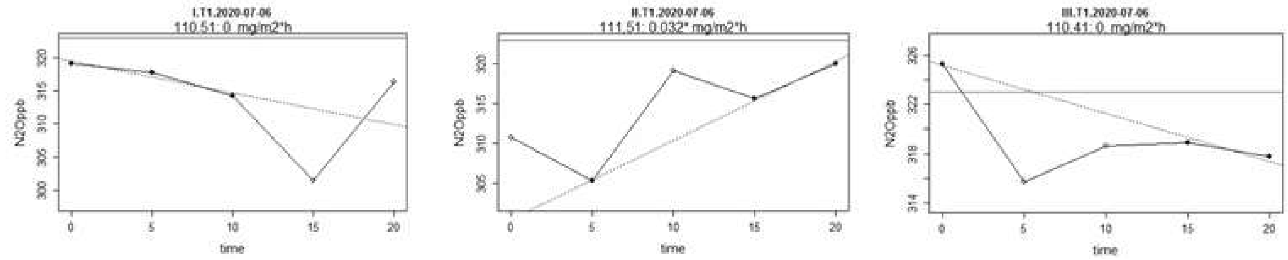

Figure 5. N2O emission 07.06.2020

Fig.4. Linear uCity city plan (option)

The concept of a linear city contributes to the reduction of harmful emissions into the urban atmosphere, the reduction of road construction costs, the elimination of traffic accidents and the restoration of an environmentally friendly comfortable environment. Such a city is cluster-type urban settlement, where the surface of the earth is meant for pedestrians and green plants, while transport, energy and information networks are elevated above the ground on the "second level". There is only one mode of transportation in the city - horizontal lifts connecting the high-rise towers, spaced at 500 meters and more (up to 3 km) from each other and placed along one line, or several parallel and intersecting lines. Linear cities can be built in the mountains, desert and waterlogged areas, including complex terrain, as well as on the sea shelf.

The roofs of the houses are made in the form of glazed greenhouses, which are united with each other by a central communication corridor 2–3 m wide, meant for laying engineering networks and servicing technological transport. The use of building roofs for greenhouses reduces water consumption for growing organic products, and additionally solves the problem of seasonal availability of fresh products. At the same time, such houses did not take away the land from nature - the soil from under the foundation, even if it was desert sand, was moved to the roof, enriched with humus, and a garden was planted on it. The city not only did not take away the land from the planet's biosphere, but, on the contrary, added it, increasing its fertility to the level of humus.

At the ends of such a "horizontal skyscraper" are equipped technical rooms and installed freight elevators. The basement floor is located on a common foundation for the entire length of the building and has a technical passage in the center 2–3 m wide for service equipment. There is space for growing microgreens and mushrooms, keeping quails and other small birds and animals, as well as for breeding aquaculture. In order to jointly operate the building and manage technological processes at all levels, a condominium is organized. The use of these biotechnologies provides for waste-free processes of year-round cultivation and consumption of organic food. Instead of waste at the end of the technological agricultural cycle in the linear city cluster, uTerra biological humus is obtained, which is returned here in the cluster in the form of organic fertilizers to the new cycle.

CONCLUSIONS

Unitsky's String Transport (uST) allows to preserve the natural land cover, which can be used for growing crops. On the example of the considered agriculture, the absorption of about 4 t / ha per year of CO_2 is ensured (which corresponds to 1 km of the length of a traditional road), while the environment is not polluted and the natural fluxes of CH_4 and N_2O do not increase, which is a favorable factor for the climate and ecology.

The considered innovative transport does not violate the nature and, among other things, allows preserving the natural migration routes of wild animals. As a result, the area through which the string-rail road's pass can be used for organic agriculture, which, in turn, creates a minimal environmental burden on the biosphere. Biospheric technologies of the linear city (greenhouse construction of roofs, cultivation of basidiomycetes, quails and aquacultures in the basement, vermicomposting of waste) significantly improve the balance of human-nature relations and make it possible to globally reduce the anthropogenic load.

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