THE PRODUCTIVITY AND BIOGEOCHEMICAL TURNOVER OF LANDSCAPES

CONFERENCE TO THE 100TH ANNIVERSARY OF PROF. N.I. BAZILEVICH (MOSCOW REGION, APRIL 2010)

2010 is the 100th anniversary of the birth of Natalia Bazilevich, an outstanding specialist in soil science, biogeochemistry, geography, and ecology who has worthily represented the cohort of encyclopedically educated Russian scientists of the 20th century, such as V.V. Dokuchaev, V.I. Vernadsky, and A.A. Grigor'ev and contributed to the development of their ideas. To commemorate this remarkable date, the scientific community has decided to sum up advances in the scientific field pioneered, among others, by Prof. Bazilevich.

Bazilevich's studies still have a high citation index, holding due place among classic publications. For more than 40 years, her books and articles remain high on the reference lists of university courses in general soil science and soil geography, geobotany, landscape science, ecology, and biogeochemistry.

The Institute of Geography (Russian Academy of Sciences), together with the Institute of Physicochemical and Biological Problems in Soil Science (Russian Academy of Sciences), the Institute of Soil Science and Agrochemistry (Siberian Branch, Russian Academy of Sciences), and the Dokuchaev Soil Science Institute (Russian Academy of Agricultural Sciences), with participation of the Moscow State University and the Dokuchaev Society of Soil Scientists, convened a conference dedicated to the 100th anniversary of Bazilevich's birth. This conference, entitled "The Geography of Productivity and Biochemical Cycle of Terrestrial Landscapes," was held in Pushchino (Moscow Region) on April 19 to 22, 2010[1].

The conference, hosted by the Institute of Physicochemical and Biological Problems in Soil Science, proceeded in a friendly working atmosphere and was marked by a high degree of participation by young specialists. The first plenary session and round-table discussion were devoted directly to Bazilevich's scientific heritage and new aspects of her biography. Other problems addressed at the conference were as follows: the geography of landscape productivity, the biogeochemical cycle in terrestrial landscapes, carbon turnover in terrestrial landscapes, modeling of biogeochemical cycles and land ecosystem functioning, soil organic matter and role of the biota in its dynamics, and new methods for studying productivity and carbon turnover in land ecosystems. On the whole, the Organizing Committee received abstracts of 149 communications from research teams working in 20 Russian cities and also in Belarus, Norway, Germany, and Great Britain.

The accepted abstracts and invited lectures (a book with CD-ROM)[2] and the monograph by N.I. Bazilevich and A.A. Titlyanova (a book with CD-ROM)[3] were published by the beginning of the conference.

[1] Full report is to be published in "Pochvovedenie" magazine (2011, #5).

[2] The Geography of Productivity and Biochemical Cycle of Terrestrial Landscapes. Proc. Conf. Dedicated to the 100th Anniversary of the Birth of Prof. N.I. Bazilevich, Pushchino, Moscow Region, April 19–22, 2010: Dobrovol'skii, G.V., Kudeyarov, V.N., and Tishkov, A.A., Eds., Pushchino, 2010.

[3] Bazilevich, N.I. and Titlyanova, A.A., Biotic Turnover on the Five Continents: Nitrogen and Ash Elements in Natural Land Ecosystems), Tishkov, A.A., Ed., Novosibirsk: SO RAPN, 2008.

As noted above, the first plenary session was devoted to Bazilevich's scientific heritage and the present-day significance of her ideas. After the welcome address by V.N. Kudeyarov, the session began with the lecture "Productivity of the World's Grassland Ecosystems" by A.A. Titlyanova (Institute of Soil Science and Agrochemistry, Novosibirsk). The author presented a comparative geographic analysis of parameters characterizing phytomass stocks and production in the steppes, prairies, grassland savannas, and their analogs on the five continents. Its results show that these are the most productive of all land ecosystems, with their exclusive dynamism providing for sustainability in their structure and functioning.

V.N. Kudeyarov (Institute of Physicochemical and Biological Problems in Soil Science, Pushchino) in his lecture "Assessment of Negative CO_2 Balance on the Territory of Russia" emphasized the significance of estimates made by Bazilevich for present-day models of carbon balance. Approximately 25–40% of atmospheric CO_2 in land ecosystems is of soil origin, and the soil cover as a whole hold the key position in the atmospheric turnover of CO_2 and other gases.

A.S. Vladychenskii (Faculty of Soil Science, Moscow State University) presented the lecture "Biogeochemical Turnover and Soil Formation in Mountain Conifer Forests," in which he followed the best traditions of data presentation established by Bazilevich in her comprehensive studies of the 1960s to 1980s. The author considered recent data on biogeochemical turnover in ecosystems of the forest belt (1400–1900 m a.s.l.) in the Teberda Nature Reserve and showed that the regime of ecosystem functioning observed in this region accounts for the formation of burozem soils.

The lecture "Natalia Ivanovna Bazilevich: Portrait of the Scientist, Heritage, and New Life of Ideas" by A.A. Tishkov, E.I. Pankova, and N.G. Tsarevskaya (Institute of Geography, RAS, and Dokuchaev Soil Institute, Moscow) dealt with new data for the biography of N.I. Bazilevich and the development of her ideas lying at the basis of several research fields in soil science, ecology, and geography.

The same problems were addressed at the evening round-table discussion held in April 20, where the floor was taken by A.A. Titlyanova, T.V. Tursina, E.I. Pankova, I.V. Ivanov, A.A. Tishkov, Yu.G. Puzachenko, V.A. Rozhkov, L.O. Karpachevskii, and N.V. Lukina.

The second session was devoted to studies on the productivity of zonal and intrazonal ecosystems. It opened with the lecture "The First Digital Maps of Phytomass, Mortmass, and Annual Production" (by V.A. Rozhkov and A.Z. Shvidenko (Dokuchaev Soil Science Institute, Moscow). The lecturer described the first experience in digitizing Bazilevich's database (1993) and making computer maps. Even today, decades later, these materials remain relevant and are used in attempts to gain insights into a number of global problems.

L.O. Karpachevskii (Faculty of Soil Science, Moscow State University) in his lecture "Necromass in Natural Biogeocenoses" proposed a new classification of plant necromass and expressed his understanding of its nature.

Interesting presentations at this sessions were also given by E.A. Golovatskaya (Institute for Monitoring Climatic and Ecological Systems, Siberian Branch, RAS, Tomsk); I.V. Bezkorovainaya (Sukachev Institute of Forest, Siberian Branch, RAS, Krasnoyarsk); N.V. Lukina, M.A. Orlova, T.T. Gorbacheva, and E.A. Belova (Center of Forest Ecology and Productivity, RAS, Moscow, and Institute of Industrial Ecology of the North, Kola Scientific Center, RAS, Murmansk Region); A.D. Sambuu (Tuva Institute for Exploration of Natural Resources, Siberian Branch, RAS, Kyzyl); and P.V. Kuznetsov, I.M. Yashin, and V.I. Grebenshchikova (Vinogradov Institute of Geochemistry, Siberian Branch, RAS, Irkutsk).

At the third session, the participants considered problems in the study of biogeochemical turnover in terrestrial landscapes. Among lectures presented at the session, particularly noteworthy were the following: "Turnover of Nitrogen and Ash Elements in Ecosystems of Steppe Rangelands" by N.Yu. Kulakova and B.D. Abaturov (Severtsov Institute of Ecology and Evolution, RAS, Moscow, and Institute of Forest Science, RAS, Moscow Region); "Solodized Soils of Subarid Landscales and Processes Accounting for Their Formation" by T.V. Tursina (Dokuchaev Soil Science Institute, Moscow); "Biogeochemical Turnover and Balance of Chemical Elements in Agrolandscapes" by N.K. Chertko and A.A. Karpichenko (Belarusian State University, Minsk, Belarus); and "Assessment of Parameters of Nitrogen Mass Balance in Ecosystems of the Yamal Peninsula for the Purposes of Ecological Rating" by I.V. Priputina and V.N. Bashkin (Institute of Physicochemical and Biological Problems in Soil Science, Moscow Region). It should be noted that the data reported by T.V. Tursina confirm Bazilevich's idea that a possible way of solod soil formation is that from salinized soils of waterlogged steppe depressions.

The fourth session, dealing with carbon exchange in terrestrial landscapes and soils, was especially rich in presentations. In particular, V.M. Semenov (Institute of Physicochemical and Biological Problems in Soil Science, Pushchino) used a new methodological approach to contemplate on the nature of soil organic matter, its composition, conditions of stabilization, and capacity for mineralization. D.G. Zamolodchikov, G.N. Kraev, and D.G. Shmelev (Center of Forest Ecology and Productivity, RAS, and Faculty of Geography, Moscow State University) in the lecture "Estimations of Carbon Budget in Russian Forests: Problems and Possible Solutions" presented original calculations for estimating the contribution of Russian forests to the global carbon balance. L.S. Sharaya, E.G. Kolomyts, and G.S. Rozenberg (Institute of the Ecology of the Volga Basin, RAS, Tolyatti) considered the results of modeling and prediction of carbon balance in forest ecosystems under conditions of global warming. The lecture "Biogenic Carbon Fluxes in Boreal Forests of Central Siberia" by E.F. Vedrova (Sukachev Institute of Forest, Krasnoyarsk) provided evidence that, among fir forests, medium-aged and mature stands accumulate carbon, whereas production and mineralization in old-growth stands are close to equilibrium.

I.O. Alyabina and L.G. Bogatyrev (Institute of Ecological Soil Science, Faculty of Soil Science, Moscow State University) presented the results of constructing a map of carbon fixation in geochemical landscapes. These authors developed original cartographic and typological methods that allowed them to perform a comparative geographic analysis and obtain new data on trends in the behavior of organic carbon. Data concerning regional aspects of carbon balance were presented by Yu.B. Tsybenov et al. (Institute of General and Experimental Biology, Siberian Branch, RAS, Ulan-Ude) for Transbaikalia; by A.V. Ol'chev et al. (Severtsov Institute of Ecology and Evolution, RAS, Moscow; Technical University of Denmark, Roskilde; Faculty of Geography, Moscow State University; and Georg-August University, Goettingen, Germany) for moist tropical forests of Indonesia; by V.O. Lopez de Gerenu et al. (Severtsov Institute of Ecology and Evolution, RAS, Moscow; Institute of Physicochemical and Biological Problems in Soil Science, Moscow Region; and Joint Russo-Vietnamese Science and Technology Tropical Center, Ho Chi Minh City, Vietnam), for tropical forests of Vietnam, and by I.V. Kovda, E.G. Morgun, and N.I. Golubeva (Institute of Geography, RAS; Faculty of Soil Science, Moscow State University; and Southern Scientific Center, RAS, Rostov-on-Don) for mountain ecosystems of the Caucasus.

A number of presentations at this session were devoted to the behavior of carbon and other elements in soils in the course of agrogenic successions, including those taking place today due to large-scale abandonment of farmlands and their overgrowing by forest. In the lecture "Reflections of Recent and

Past Agrogenic Impacts in the Distribution of Biogenic Silica over the Profiles of Soddy Podzolic Soils," A.A. Gol'eva, N.P. Sorokina, and I.V. Kuznetsova (Institute of Geography, RAS, and Dokuchaev Soil Science Institute, Moscow) described the results of indication of changes in arable soils by the phytolith method. I.V. Ivanov and Yu.G. Chendeev (Institute of Physicochemical and Biological Problems in Soil Science, Pushchino, and Faculty of Geology and Geography, Belgorod State University, Belgorod) presented the lecture "Chernozem Soils of the Central Chernozem Zone: History of Formation and Current State of Humus Profile." On the basis of paleopedological data, these authors performed a detailed analysis of changes in the properties of chernozems during the Late Glacial to Subatlantic time and in the recent period, when the humus content of these soils has decreased by 25–70% as a result of plowing.

D.I. Lyuri, S.V. Goryachkin, N.A. Karavaeva, O.Yu. Kalinina, and L. Giani (Institute of Geography, RAS, Moscow, and University of Oldenburg, Germany) presented the lecture "Atmospheric Carbon Deposition in Fallow Lands of Russia." These authors evaluated the extent and potential of carbon sink in the course of restorative succession in fallow lands of European Russia and arrived at interesting conclusions as to what happens to fallow lands in terms of the fate of humus and soil organic matter.

The fifth session was devoted to new methods in studies on productivity, biological turnover, and factors determining their parameters. The opening lecture by Yu.G. Puzachenko (Severtsov Institute of Ecology and Evolution, RAS) was entitled "The Climatic Space of the Biosphere." The author presented his understanding of this space in terms of volume (entropy) and structure and showed a strong nonlinear dependence of net production on temperature, precipitation, and their ratio. Yu.A. Plyushkyavichyute, E.I. Golubeva, O.V. Tutubalina, and W.G. Rees (Faculty of Geography, Moscow State University, and Scott Polar Research Institute, University of Cambridge, UK) analyzed the possibilities of remote sensing methods in the assessment of aboveground phytomass in the taiga–tundra ecotone. Interrelations between vegetation and soil in forest–tundra ecotones were considered from new methodological positions in the lecture by M.A. Orlova et al. (Center of Forest Ecology and Productivity, Moscow; Faculty of Geography, Moscow State University; Institute of Industrial Ecology of the North, Apatity; and Norwegian Institute for Nature Research, Norway). Both were performed on the Kola Peninsula.

V.O. Lopez de Gerenu et al. (Institute of Physicochemical and Biological Problems in Soil Science, Pushchino, and Timiryazev State Agricultural University, Moscow) in the lecture "In Situ Determination of Carbon Balance Components in a Meadow Ecosystem in Central Russia" showed that field experimental methods offer ample opportunities for studies on carbon fluxes.

R.B. Sandlerskii and A.N. Krenke (Severtsov Institute of Ecology and Evolution and Institute of Geography, RAS, Moscow) demonstrated the possibility of combining remote sensing and field methods in studies on the dependence of the productivity of southern taiga landscapes on their topography and vegetation.

The sixth session – "Modeling of Biogeochemical Cycles and Ecosystem Productivity"began in the absence of A.S. Komarov, its organizer and intended chairman, who could not arrive from Europe on time because of the Eyjafjallajokull volcano eruption in Iceland. Although its program was abridged, the lectures stimulated a vivid discussion. T.A. Arkhangelskaya (Faculty of Soil Science, Moscow State University) presented a mathematical model of carbon dynamics in geochemically interrelated soils of the Vladimir Opolye region. This model made it possible to estimate the characteristic time of humus horizon formation, with the results being consistent with data by R.V. Desyatkin

on dating Yakutian alass soils and with micromorphological data by A.O. Makeev and I.V. Dubrovina.

L.L. Golubyatnikov (Obukhov Institute of Atmospheric Physics, Russian Academy of Sciences, Moscow) made a comparative analysis of global and regional model estimates of plant cover productivity, juxtaposing the results with calculations made by Bazilevich. The values of phytomass stock and production obtained with many models proved to be similar to her data. M.B. Bobrivskii et al. (Institute of Physicochemical and Biological Problems in Soil Science, Pushchino) described the results of modeling the dynamics of soil carbon in different variants of traditional agriculture and forest management practiced in central European Russia. He also presented a synopsis of A.S. Komarov's lecture "Modeling the Biogeochemical Cycles of Chemical Elements in Forest Ecosystems." A.S. Naumov (Institute of Soil Science and Agrochemistry, Novosibirsk) in the lecture "The Production–Destruction Link of the Biotic Turnover: Global Aspect" analyzed the initial data on the nitrogen contents of basic phytomass fractions in land ecosystems from the monograph Biotic Turnover on the Five Continents: Nitrogen and Ash Elements in Natural Land Ecosystems (Bazilevich and Titlyanova, 2008) and revealed new trends in the ratio between components of the nitrogen cycle in the biosphere.

In conclusion, it appears appropriate to give a brief outline of the results of the conference and the relevance and significance of Bazilevich's books, ideas, and scientific heritage in the present period.

First, the conference has provided evidence for the increasing interest in the problems of global carbon balance and the role of soils in it. The question as to what are the contributions of natural and anthropogenic factors in processes responsible for recent climate change is difficult to answer without referring to the data obtained by N.I. Bazilevich, and her name will long be mentioned in discussions on the key role of soils in the accumulation of biogenic (humus) and hydrogenic (carbonates) carbon and in global carbon fluxes. This aspect of Bazilevich's research is consistently pursued at centers engaged in the elaboration of scientific foundations for implementing the United Nations Framework Convention on Climate Change and the Kyoto Protocol to this convention. An interesting fact is that M.A. Glazovskaya in her recent monograph "Pedolithogenesis and Continental Cycles of Carbon" (2009) notes that studies on the role of pedosphere in these cycles can help reveal the causes of imbalance between carbon dioxide absorption on land and its return to the atmosphere, which has been observed in the past decades. Bazilevich also paid attention to this aspect but limited herself to the assessment of soil carbon in the upper 100-cm layer, as do many authors of recent studies.

Second, consisten10t attention is paid to the results of Bazilevich's studies on the productivity of zonal landscapes, which have been processed and systematized. In particular, they are used for interpretation and comparative analysis of data on the assessment of net primary production by means of the normalized difference vegetation index (NDVI), which is determined on the basis of remote sensing data (from the difference between signals in the visible red and infrared spectral channels of the SPOT, Landsat, Terra, IRS, Aqua, and other satellite systems). Research in landscape productivity is carried out at major scientific centres of RAS.

Third, N.I. Bazilevich initiated the construction of conceptual balance models of zonal and intrazonal ecosystems, and her data were included in mathematical models constructed in the 1980s. Thereafter, this research field has been successfully explored by Yu.M. Svirezhev, A.M. Tarko, A.S. Komarov, D.O. Logofet, L.L. Golubyatnikov, T.G. Gil'manov, and their followers. Today,

such studies are underway at many institutes of the RAS.

Fourth, the line of Bazilevich's research concerning the geography of biogeochemical turnover is also being developed today. As noted above, the conference was marked by the publication of the monograph "Biotic Turnover on the Five Continents: Nitrogen and Ash Elements in Natural Land Ecosystems" (Bazilevich and Titlyanova, 2008) based on materials from N.I. Bazilevich's archive. This book has attracted great interest because of its global scope and the opportunity provided for a researcher to compare the results of his/her own local observations with generalized data obtained in studies of biogeochemical cycles in zonal ecosystems on other continents, including those with convergent structure. New methods and analytical technologies make it possible to promptly obtain detailed data on the element composition of plants, animals, soils, and natural waters as well as to make gas measurements to determine soil respiration and concentrations of various chemical compounds in the atmosphere. Such studies are actively performed at the Institute of Physicochemical and Biological Problems in Soil Science, Vernadsky Institute of Geochemistry and Analytical Chemistry, Department of Soil Geography and Evolution of the Institute of Geography (Russian Academy of Sciences); Dokuchaev Soil Science Institute (Russian Academy of Agricultural Sciences); Institute of Geochemistry, Institute of Soil Science and Agrochemistry, Institute of Geography (Siberian Branch, Russian Academy of Sciences); Department of General Soil Science, Faculty of Soil Science; Department of Landscape Geochemistry and Soil Geography, Faculty of Geography; Laboratory of Matter Turnover and Energy Fluxes in the Pedosphere, Institute of Ecological Soil Science (Moscow State University); and many other centers.

It is noteworthy that Bazilevich's personality and her pioneering studies attracted major interest from young scientists. At every session, they were offered an opportunity to give two to three lectures, and the poster session (a total of about 20 presentations) was focused on achievements made by postgraduate students and young researchers specialized in soil science, geography, and ecology.

Summing up the results of the conference, it should be noted that the biological line of research in soil science has been developed extensively, covering all geographic regions of Russia and territories of bordering countries. The large proportion of young scientists among the participants and the high scientific level of their presentations are prerequisites for further advancement of Bazilevich's ideas. Her studies in different branches of biogeochemistry have a very high citation index both in Russia and abroad, ranking high above publications of other authors working in this field, which is additional evidence for the profound views and extensive foresight of this great woman scientist.

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