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THE ENVIRONMENTAL HISTORY OF THE RUSSIAN STEPPES: VASILII DOKUCHAEV AND THE HARVEST FAILURE OF 1891*

By David Moon

READ 22 OCTOBER 2004 AT THE UNIVERSITY OF THE WEST OF ENGLAND

ABSTRACT. This article examines aspects of the environmental history of the Russian steppes in the long term and in a comparative framework by focusing on the work of the prominent Russian scientist Vasilii Dokuchaev in response to the drought and harvest failure that afflicted large parts of the steppes in 1891. Dokuchaev analysed the causes of the disaster in the long-term context of natural and human-induced changes in the environment. He drew up a plan to address the environmental constraints on agriculture in the region, and led a scientific expedition to examine the feasibility of putting parts of his plan into practice.

In 1891 large parts of the steppe region of southern and south-eastern Russia were hit by a serious drought, which caused the harvest to fail across a wide area, and contributed to a famine that lasted long into 1892. The commercial attache in the British embassy in St Petersburg, E. F. G. Law, conveyed the scale of the disaster with his estimate that the Imperial Russian government had ‘to find the means of supplying a deficit of food to 35,500,000 people in sixteen provinces’. His report was not positive about the ability of the Imperial Russian government and population to alleviate the consequences of the harvest failure, nor about the prospects for Russian agriculture in the medium term.¹ The subject of this essay is not the famine or the attempts by the government and society to alleviate

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¹ *Russia. Report on Russian Agriculture and the Failure of the Harvest in 1891* (UK) Foreign Office, 1892, Miscellaneous Series No. 254, Reports on Subjects of General and Commercial Interest (1892), quotation, 21.

the human suffering.² Rather, the aim is to analyse the response to the drought and harvest failure by Russian scientists, in particular the prominent soil scientist Vasilii Dokuchaev in the long-term context of the environmental history of the Russian steppes. The unfolding catastrophe prompted Russian scientists to investigate its causes and to propose ways of dealing with the recurring problem of droughts and crop failures on the steppes. The most comprehensive study was carried out by Dokuchaev. He examined the causes of the drought and harvest failure in a book entitled *Our Steppes: Past and Present*, which was published in the spring of 1892.³ He considered the evolution of the steppe environment over the millennia since the end of the last ice age, and the more recent impact of human activity on what he termed 'virgin nature'. Dokuchaev believed that this human impact was partly responsible for the harvest failure. At the end of the book, he presented a detailed plan of measures to prevent such future disasters by seeking to reverse the impact of human action and to 'improve' nature. The government sponsored Dokuchaev to lead a major scientific expedition to the steppes to carry out research into the viability of putting some of the measures into practice. The environmental history of the Russian steppes has broader significance. The steppes were one of several grassland regions around the globe, for example the prairies of north America, that came under the plough from the eighteenth or nineteenth centuries and experienced similar environmental problems. Scientists in all these regions examined and debated what was taking place.

I

The steppe region⁴ of the south and south-east of the territory of the European part of the Russian Empire (contemporary European Russia and Ukraine) is part of the immense Eurasian steppes that extend from the Hungarian plain in the west to Mongolia and northern China in the east.

² For works in English on the famine, see R. G. Robbins, *Famine in Russia, 1891–1892: The Imperial Government Responds to a Crisis* (New York and London, 1975); J. Y. Simms, 'The Crop Failure of 1891: Soil Exhaustion, Technological Backwardness, and Russia's "Agrarian Crisis"', *Slavic Review*, 41 (1982), 236–50; *idem*, 'The Economic Impact of the Russian Famine of 1891–92', *Slavonic and East European Review*, 51 (1982), 63–74; S. G. Wheatcroft, 'The 1891–92 Famine in Russia: Towards a More Detailed Analysis of its Scale and Demographic Significance', in *Economy and Society in Russia and the Soviet Union, 1860–1930*, ed. L. Edmondson and P. Waldron (Basingstoke and London, 1992), 44–64.

³ V. V. Dokuchaev, 'Nashi Stepi prezhde i teper', in *Sochineniya* (9 vols., Moscow and Leningrad, 1949–61), VI, 13–102 (first published in book form as V. V. Dokuchaev, *Nashi Stepi prezhde i teper'* (Spb, 1892)).

⁴ On the wide variety of regions and their significance, see D. Saunders, 'Regional Diversity in the Later Russian Empire', *Transactions of the Royal Historical Society*, sixth series, 10 (2000), 143–63.

In Russia, between the steppes and the forest zone to the north, is a belt of transitional forest-steppe, where areas of open land are interspersed with woodland. In the south, however:

up to the shores of the Black Sea, over a vast area is stretched a treeless, lightly rolling plain, here scored by deep gullies, there smooth and level for hundreds of versts,⁵ [formerly] covered in the main by a herbaceous steppe vegetation, or in some parts also by steppe shrubs . . . The real high steppes are so bereft of woody vegetation that their horizon, sometimes for many hundred versts, is not broken by a single tree. Only in the deep ravines and along the valleys of the rivers [e.g. the Dnepr, Don and Volga] intersecting the steppes, where the conditions of moisture are more favourable, thick growths of shrubs find shelter and clumps of trees lift their heads. The steppe, [where it is] as yet untouched by the plough, strikes the observer with the wealth and beauty of its flora, the rapid changeability of its colouring at different seasons of the year and the abundance of animal life.

This was how the Russian Department of Agriculture (of the Ministry of State Domains) described the steppes in a volume prepared for the World's Columbian Exposition in Chicago in 1893. The description carried on:

During the last few decades tillage has greatly altered the steppe region. The untouched virgin steppes with their peculiar vegetation and life in the majority of places have vanished yielding room to endless fields of wheat and other kinds of grain. The virgin steppe is preserved only here and there in unfrequented spots, where the population is thinner and where the plough has not yet broken up all the land possible.

Readers were referred for more detailed information to an English translation of Professor Dokuchaev's book on the Russian steppes that had been prepared specially for the exposition. The translation of Dokuchaev's book had an additional chapter on 'The Study of the Soil', in particular the celebrated, prodigiously fertile, black earth (*chernozem*), that covered the largest part of the steppes.⁶

The steppes were not ancient Russian or Slavonic lands. Nor had arable farming been the main activity of the inhabitants for most of their recorded history. Most of the region had come under Russian control since only the mid-sixteenth century, and the treeless steppes to the south were settled and cultivated by a predominantly Slavonic population from only the eighteenth century. The first written description of the region to the north of the Black Sea is from a very long time before the Russian

⁵ 1 versta = 0.66 of a mile or 1.06 km.

⁶ *The Industries of Russia*, III: *Agriculture and Forestry*, ed. John Martin Crawford (Spb, 1893), xxii–xxiii (originally published as *Sel'skoe i lesnoe khozyaistvo Rossii* (Spb, 1893)); V. V. Dokuchaev, *The Russian Steppes. Study of the Soil in Russia, its Past and Present*, ed. John Martin Crawford (Spb, 1893). For descriptions of the steppe environment preserved in scientific nature reserves (*zapovedniki*) in contemporary Russia, Ukraine and Moldova, see *Zapovedniki evropeiskoi chasti RSFSR*, II, ed. M. N. Stroganova (Moscow, 1989); *Zapovedniki Ukrainy i Moldavii*, ed. E. E. Syroechkovskii (Moscow, 1987).

conquest and settlement, however, when it was on the fringes of the world of the Ancient Greeks, and belonged to Herodotus.⁷ Writing in the middle of the fifth century BCE, Herodotus described the land he knew as Scythia as a 'level plain with good deep soil', which was watered by numerous rivers, for example the Tanais (the Don),⁸ and which was 'treeless', with the exception of an area he called Hylaea, which was probably located near the mouth of the river Dnepr in contemporary Ukraine.⁹ The most notable features of the climate, for this native of Asia Minor, were the long, hard winters and violent thunderstorms in the summer. A Soviet historian of climate wryly noted that Herodotus exaggerated the length of the winters and, like other travellers from the Mediterranean world, tended to note the cold winters rather than the hot summers on the steppes.¹⁰ Herodotus's Scythia was inhabited partly by settled agricultural tribes, who grew grain and other crops, and partly by nomadic peoples, who lived off their livestock and knew 'nothing of agriculture'. Settled agriculture had spread to parts of the west of the Eurasian steppes long before the 'father of history' described the region. For several millennia, however, from around 3,000 BCE to the latter part of the second millennium CE, the steppes were inhabited largely by nomadic pastoralists. The nomads grazed their flocks of sheep and goats and herds of cattle, horses and camels on the rich grasslands that flourished on the 'good deep soil'. Over these millennia, a succession of nomadic peoples, including the Scythians, Huns and Mongols, invaded from the east. In the thirteenth century, the Mongols under Chinghiz Khan and his sons and grandsons conquered the entire Eurasian steppes and surrounding territories, including much of contemporary Russia and Ukraine. Under pressure from the regular invasions and raids by nomadic pastoralists, settled agricultural peoples moved north and north-west from the steppes

⁷ Herodotus, *The Histories*, trans. Aubrey de Selincourt, further rev. edn (2003), IV, 17–23, 28–9, 46–58.

⁸ The identification of Herodotus's 'Tanais' has been the subject of debate. A. P. Medvedev, 'K voprosu ob identifikatsii reki Tanais po dannym Ptolemeia', in *Istoricheskaya geografiya chernozemnogo tsentra Rossii (dooktyabrskii period)*, ed. V. P. Zagorovskii (Voronezh, 1989), 132–49.

⁹ Herodotus's description of the steppes as 'treeless' and attempts to locate 'Hylaea' played an important role in a long-running debate over whether the steppes had once been forested. See, for example: I. Palimpsestov, *Stepi yuga Rossii byli-li iskom vekov stepami i vozmozhno-li oblesit' ikh?*, rev. edn (Odessa, 1890), 128–54; V. Taliev, 'Bednyi Gerodot i drugie "svetil'niki" v rukakh pochvenno-botanicheskoi geografii', *Estestvoznaniye i geografiya*, 8 (1905), 28–43. See also D. Moon, 'Were the Steppes ever Forested? Science, Economic Development, and Identity in the Russian Empire in the 19th Century', in *Dealing with Diversity: 2nd International Conference of the European Society for Environmental History: Proceedings*, ed. L. Jelecek et al. (Prague, 2003), 206–9.

¹⁰ I. E. Buchinskii, *O klimate proshlogo Russkoi ravniny* (Leningrad, 1957), 44–6.

into what became northern Ukraine and central Russia, where the forests afforded them some protection.¹¹

Over time, states based on settled farming on the periphery of the steppes built up advantages over nomadic empires. In particular, agrarian states developed the ability to support larger populations and centralised administrations that could mobilise their resources, principally land and people, to maintain powerful armed forces. The tide turned in favour of the agrarian state based on Moscow in the 1550s. Tsar Ivan the Terrible defeated two of the successor states of the Mongol Empire, the Khanates of Kazan' and Astrakhan', on the middle and lower Volga. This proved to be the start of the Russian conquest of the steppes, which was spearheaded by bands of cossacks. By the end of the eighteenth century, the Russian Empire had extended its southern borders to the northern shores of the Black and Caspian seas and into the foothills of the Caucasus mountains. In the process, the steppes were opened to settlement by large and growing numbers of peasant farmers (mostly Russians and Ukrainians but also some Germans), who moved south and east out of the forests and on to the fertile plains. In time, peasant farmers displaced the nomads and replaced their extensive pastoral economy with settled agriculture.¹² Peasant settlement of the open steppes in the south and south-east took off in the mid-eighteenth century. In 1719, the total peasant population of the region was a little over 50,000. Less than two centuries later, at the time of the 1897 census, there were nearly 5 million peasants on the open steppes. In addition, there were almost 2.4 million cossacks in the region, many of whom, since the late eighteenth century, engaged in arable farming.¹³

The main attractions for the peasants who moved on to the steppes were the prospects of greater freedom, away from the oppression and exploitation of life in the central regions, and of relative prosperity from

¹¹ D. Christian, *A History of Russia, Central Asia and Mongolia*, 1: *Inner Eurasia from Prehistory to the Mongol Empire* (Oxford, 1998), 77–80, 85; M. Zvelebil and P. Dolukhanov, 'The Transition to Farming in Eastern and Northern Europe', *Journal of World Prehistory*, 5 (1991), 248–62.

¹² See D. Christian, 'Inner Eurasia as a Unit of World History', *Journal of World History*, 5 (1994), 173–211; M. Khodarkovsky, *Russia's Steppe Frontier: The Making of a Colonial Empire, 1500–1800* (Bloomington and Indianapolis, IN, 2002); W. H. McNeill, *Europe's Steppe Frontier, 1500–1800* (Chicago, 1964); D. Moon, 'Peasant Migration and the Settlement of Russia's Frontiers 1550–1897', *Historical Journal*, 30 (1997), 859–93; W. Sunderland, *Taming the Wild Field: Colonization and Empire on the Russian Steppe* (Ithaca, NY, 2004).

¹³ Data from V. M. Kabuzan, *Izmeneniya v razmeshchenii naseleniya Rossii v XVIII-pervoi polovine XIX v. (Po materialam revizii)* (Moscow, 1971), 59–175 (figures for males have been doubled); *Obshchii svod po imperii rezul'tatov razrabotki dannykh pervoi vseobshchei perepisi naseleniya, proizvedennoi 28 Ianvarya 1897 goda*, ed. N. A. Troitskii (2 vols., Spb, 1905), 1, 165–71. On the settlement of southern Ukraine, see E. I. Druzhinina, *Severnoe Prichernomor'e v 1775–1800 gg.* (Moscow, 1959); *idem*, *Yuzhnaya Ukraina v 1800–1825 gg.* (Moscow, 1970); *idem*, *Yuzhnaya Ukraina v period krizisa feodalizma 1825–1860 gg.* (Moscow, 1981). See also R. P. Bartlett, *Human Capital: The Settlement of Foreigners in Russia, 1762–1804* (Cambridge, 1979). On cossacks, see S. O'Rourke, *Warriors and Peasants: The Don Cossacks in Late Imperial Russia* (New York, 2000).

cultivating the rich, black earth.¹⁴ The fertility of the black earth of the steppes was noted by the predominantly German scientists who took part in expeditions organised by the Russian Academy of Sciences in the late 1760s. Samuel Georg Gmelin described the steppes as a land which the 'Providential Creator had endowed with fertility' and where there were great prospects for the development of agriculture.¹⁵ Peter Pallas, who returned to the steppes in 1790s, waxed lyrically about the productivity of the virgin land around Taganrog (on the Sea of Azov). He may have been exaggerating, however, when he wrote that the land: 'is so fertile that in a recently tilled soil, wheat may be sown without manure during four or five successive years; its crops frequently are from twenty to thirty fold and in good seasons, even thirty-eight grains are obtained from one'.¹⁶ Another of the Academy's German scientists, Johann Anton Gueldenstaedt, made the more sober but still high estimate of grain yields of 1:10 on the Don steppes in the early 1770s.¹⁷ The expeditions organised by the Academy of Sciences in the late eighteenth century were the start of serious scientific study of the steppes, and were precursors to Dokuchaev's expeditions over a century later. In the decades after Pallas and his colleagues explored the steppes, the Russian government sought to promote the agricultural development of the steppes. In 1828 it supported the foundation of the Imperial Society for Agriculture of Southern Russia in Odessa, in southern Ukraine, with the aim of improving all branches of agriculture, including growing crops, that were appropriate to the steppe environment.¹⁸ Russian officials, for example Konstantin Veselovskii – a senior figure in the Ministry of State Domains in the mid-nineteenth century – expressed optimism for the prospects of the settlement and cultivation of this fertile land. He specifically argued that the climate of the steppes was better suited to arable farming – the main occupation

¹⁴ See D. Moon, *The Russian Peasantry 1600–1930: The World the Peasants Made* (London and New York, 1999), 254–62.

¹⁵ Samuel Georg Gmelin, *Puteshestvie po Rossii dlya issledovaniya trekh tsarstv estestva* (2 vols., St Petersburg, 1771–7), I, 269–70. On the expeditions, see V. F. Gnucheva, *Materialy dlya istorii ekspeditsii akademii nauk v XVIII i XX vekakh* (Moscow and Leningrad, 1940), 97–108, 126.

¹⁶ Peter Simon Pallas, *Travels through the Southern Provinces of the Russian Empire, in the Years 1793 and 1794*, trans. from the German (2 vols., London, 1802), I, 498–9.

¹⁷ I. Ya. Gil'denshtedt, 'Dnevnik puteshestviya v Yuzhnyu Rossiyu akademika S. Peterburgskoi Akademii Nauk Gil'denshteda v 1773–1774 g.', *Žapiski Imperatorskogo Odesskogo obshchestva istorii i drevnosti*, 11 (1879), 180–228. Grain yields approaching or exceeding 1:10 were sometimes attained in good years on the steppes, especially on land only recently ploughed up, in the late nineteenth and early twentieth centuries. For high yields in the Don region, see *Gosudarstvennyi arkhiv Rostovskoi oblasti* [hereafter GARO], f.46, op.1, d.3222, l.50 ob (1894), d.3440, l.109 (1909).

¹⁸ M. P. Borovskii, *Istoricheskii obzor pyatidesyatiletnei deyatelnosti Imperatorskogo Obshchestva Sel'skogo Khozyaistva Yuzhnoi Rossii s 1828 po 1878 god* (Odessa, 1878), 5.

of the peasant settlers – than raising livestock, which had sustained the steppe nomads for millennia.¹⁹

The settlement of the steppes by Slavonic farmers, expeditions by scientists and government-sponsored development were followed by the incorporation of images of the steppe landscape into Russian (and Ukrainian) culture. An important evocation of the steppes in literature was that of Nicholas Gogol' in his novella *Taras Bul'ba* about a cossack band in sixteenth-century Ukraine. The novella contained descriptions of the treeless steppe as a 'green and gold ocean' with tall grasses that could conceal mounted cossacks up to their caps. For Gogol', moreover, the steppe was 'beautiful'.²⁰ Gogol' was describing the unploughed steppe around his home at Dikan'ka, in Poltava province, and in doing so made it famous. Dokuchaev visited Dikan'ka during one of his expeditions to Poltava province in 1888.²¹ Anton Chekhov, another native of the steppes (from Taganrog), captured the space, distance, heat, dust and monotony, but also the familiarity, of a long journey across steppes in his short story of 1888.²² The story was reputed to be a favourite of Dokuchaev's,²³ who made many such journeys. The nineteenth century witnessed the development of Russian landscape painting. Artists such as Arkhip Kuindzhi (who was from Mariupol', not far from Taganrog) painted striking landscapes of the steppes, capturing the light and the skies as well as the land, that complemented the more traditional, and some may say more 'Russian', forest landscapes.²⁴ Christopher Ely has recently argued that over the nineteenth century, many Russian writers and artists consciously constructed a landscape that incorporated forest and steppe (and rivers and mountains) as beautiful and, above all, as a national space that was 'Russian'.²⁵ The argument can be extended to late-nineteenth-century Russian music. In his symphonic poem 'In the

¹⁹ K. S. Veselovskii, 'Prostranstvo i stepen' naseleñnosti Evropeiskoi Rossii', in *Sbornik Statisticheskikh Svedenii o Rossii*, 1 (Spb, 1851), 28–9; *idem*, *O Klimate Rossii* (Spb 1857), 49–52. See also D. Mun [Moon], 'Predstavleniia o vozdeistvii khlebpashstva na prirodu stepei yugo-vostoka Evropeiskoi chasti Rossii, 1850–1900', *Izvestiia Vysshikh Uchebnykh Zavedenii. Severo-Kavkazskii region. Tubileinyi vypusk* (2002), 30–8.

²⁰ N. V. Gogol', *Taras Bul'ba*, ed. E. I. Prokhorov and N. L. Stepanov (Moscow, 1963), 16–18. See also C. Ely, *This Meagre Nature: Landscape and National Identity in Imperial Russia* (DeKalb, IL, 2002), 91–4.

²¹ I. Krupenikov and L. Krupenikov, *Puteshestviia i ekspeditsii V. V. Dokuchaeva* (Moscow, 1949), 74.

²² Anton Chekhov, 'The Steppe', in Anton Chekhov, *The Steppe and Other Stories, 1887–1891*, trans. R. Wilks, introduction by D. Rayfield (2001), 3–101.

²³ S. V. Zonn, *Vasilii Vasil'evich Dokuchaev, 1846–1903* (Moscow, 1991), 146.

²⁴ *Russian Landscape*, ed. D. Jackson and Patty Wageman (2003). [Catalogue to 'Russian Landscape in the Age of Tolstoy' at the National Gallery, London, 23 June – 12 September 2004.]

²⁵ Ely, *This Meagre Nature*.

Steppes of Central Asia' and opera 'Prince Igor' (which tells the story of a campaign against the nomadic Polovtsians in today's Ukraine in the twelfth century), Alexander Borodin skillfully interwove Russian and 'oriental' themes to symbolise the 'unification' of the diverse lands of the empire.²⁶

Russia's rulers, bands of cossacks, waves of peasant migrants, expeditions of scientists, government officials and, latterly, writers, artists and composers thus constructed images of the steppes as a land of fertile soil, opportunity, prosperity, freedom, beauty and Russianness. These images were only one side of the coin. The massive influx of settlers and the development of arable farming had a massive impact on the environment. It has been estimated that the proportion of the total land area of the region that had been ploughed up and thus converted to arable land increased from 6 per cent in 1725 to 31 per cent in 1887. This was at the expense of pasture and meadowland, woodland, which fell by almost half, and virgin steppe.²⁷ The area of land that was being ploughed up, moreover, was increasing rapidly on the eve of the disaster of 1891–2. By the early 1890s, in most provinces of the steppe region, arable land approached or exceeded half the total land area. In southern Ukraine and the Don Cossack region, the area of woodland had been reduced to only around 2 per cent of the total area.²⁸ In good years, as has already been indicated, the settlers reaped bumper harvests from the fertile land. Right from the early stages of the settlement and cultivation of the steppes, however, they also experienced periodic bad harvests that were usually caused by droughts. Gmelin reported that the harvest on the lower Don in 1769 was not profitable due to the 'excessive aridity'.²⁹ Over the nineteenth century, there were serious drought-induced harvest failures on parts of the steppes in 1822, 1832–3, 1840, the late 1840s, 1875, 1885 and 1891.³⁰ The dilemma for farmers was, and still is, that the fertile soil of the steppes does not always receive sufficient rainfall

²⁶ S. Diani, *Borodin*, trans. Robert Lord (1963), 226–8, 278–9; R. W. Oldani, 'Borodin, Aleksandr Porfir'yevich', in *The New Grove Dictionary of Music and Musicians*, 2nd edn (London and New York, 2001), III, 913–14.

²⁷ Mun, 'Predstavleniya', 31; M. A. Tsvetkov, *Izmenenie lesistosti evropeiskoi Rossii: s kontsa XVII stoletia po 1914 god* (Moscow, 1957), 111, 115, 117.

²⁸ *Sel'skoe i lesnoe khoziaistvo Rossii*, map 2 (facing 54), map 3 (facing 56). See also A. Fortunatov, 'O svyazi khlebnnykh tsen i urozhaev s nekotorymi izmeneniyami v russkom zemledelii', in *Vliyaniye urozhaev i khlebnnykh tsen na nekotorye storony russkogo narodnogo khoziaistva*, ed. A. I. Chuprov and A. S. Posnikov, I (Spb, 1897), 268; V. K. Yatsunskii, 'Izmeneniya v razmeshchenii zemledeliya v evropeiskoi Rossii s kontsa XVIII v. do Pervoi Mirovoi Voiny', in *Voprosy istorii sel'skogo khoziaistva krest'yanstva i revoliutsionnogo dvizheniya v Rossii*, ed. *idem* (Moscow, 1961), 113–48.

²⁹ Gmelin, *Puteshestvie*, I, 241.

³⁰ See A. Kahan, 'Natural Calamities and their Effect on the Food Supply in Russia,' *Jahrbuecher fuer Geschichte Osteuropas*, 16 (1968), 353–77; 'Neurozhai na Rusi', *Trudy Imperatorskogo*

to support the cultivation of cereals and fodder grasses. The unreliable rainfall and other climatic fluctuations have condemned the steppes to periodic disasters such as that of 1891–2.

II

From the perspective of environmental history, one of the most important points about the peopling and ploughing up of the Russian steppes is that the settlers moved from one type of environment to another. Thus, they encountered unfamiliar natural conditions, introduced ways of life that differed substantially from those of the previous inhabitants and in the process had a significant impact on the environment.³¹ Peasant migrants moved to the drier, fertile, grasslands of the steppes from the wetter, less fertile, forested lands of central Russia and northern Ukraine. As they displaced the nomads, much of the land they cultivated was pasture land, which in many cases had never seen a plough before, and they sowed cereal crops in place of wild grasses. It was the impact of the settlement and ploughing up of the grasslands that was at the heart of Dokuchaev's study of the steppes. Thus, the agricultural settlement of the Russian steppes provides a valuable case study of the environmental consequences of human migration. Indeed, as the prominent environmental historian John McNeill recently pointed out: 'the sweep of Russian frontier expansion' is 'cry[ing] out . . . for the attention of environmental historians'.³²

Environmental history is almost by definition global in its approach and perspective. The environmental history of the Russian steppes cannot be considered in isolation, but as part of the wider history of the interaction between humans and grasslands in temperate lands throughout the world. Dokuchaev was one of the pioneers of such a perspective in his work on environmental zones. He explicitly linked the zones of Russia with similar zones around the northern hemisphere. The Russian steppes were thus part of the 'black-earth steppes of Hungary, Russia, Asia and America' that had once all been a 'sea' of steppe grasses. The steppes of Eurasia and the prairies of north America are also similar to the pampas of southern America, the veldt of southern Africa and grasslands in Australia and New Zealand. From the eighteenth and especially the nineteenth centuries, semi-arid grasslands all around the world were being settled and ploughed up by farmers from Europe to supply the growing worldwide market for

Vol'nogo Ekonomicheskogo Obshchestva, 2, 5 (1891), 145–77; L. Vesin, 'Neurozhai v Rossii i ikh glavnye prichiny', *Severnyi vestnik*, 1 (1892), 85–123, no. 2 (1892), 41–75.

³¹ For discussion of these issues on a broader canvas, see A. J. Crosby, *Ecological Imperialism: The Biological Expansion of Europe, 900–1900* (Cambridge, 1986); J. F. Richards, *The Unending Frontier: An Environmental History of the Early Modern World* (Berkeley, CA, 2003).

³² J. R. McNeill, 'Observations on the Nature and Culture of Environmental History', *History and Theory*, 40 (2003), 30, 41–2.

grain. In all these regions, farmers from environments with fairly heavy soils and adequate rainfall encountered the problem of growing crops in environments with fertile soils, but lower and unreliable rainfall. In 'good' years, the farmers reaped bumper harvests and prospered; in years of drought, the land yielded little or nothing in return for their labour. Everywhere, moreover, removing the previous vegetation and ploughing up the land seemed to lead to the erosion of the fertile soil that had attracted the settlers in the first place.³³

In the worst years, farmers watched in horror as the wind blew away the rich soil in dust storms that obliterated the sun and their hopes for the future:

The dry autumn . . . , the snowless winter and, finally, the dry spring turned the top layer of . . . earth partly into a dry dust, [and] partly into a fine-grained, crumbly, powder, which, with the onset of strong storms in April, lost their hold, and were raised up in whole clouds, concealing the sun's rays and turning day into night. Witnesses unanimously testified that the phenomenon had such a dreadful and frightening character that everyone expected 'the end of the world'.

The source continues that it was impossible to go outdoors, trains were halted by drifts of earth blocking the tracks, crops were killed by the blows of the dust and seeds that were just starting to germinate were blown from one place to another and perished. Huge areas were left without any vegetation at all; there were not even any weeds left after the dust storms had wreaked their havoc. This image could have come from John Steinbeck's graphic depiction in *The Grapes of Wrath* of the dust bowl on the southern plains of the USA in the 1930s. It is actually a description of the dust storms on the southern steppes of Russia in the spring of 1892 by P. Zemyatchenskii, who was one of the scientists on Dokuchaev's expedition.³⁴ Another of the scientists on the expedition, N. Adamov, noted that a century earlier, in the 1790s, Pallas had described how the scorching summer winds raised clouds of dust on the steppes. This was before the wholesale ploughing up of the steppes and removal of so much

³³ See J. McNeill, *Something New under the Sun: An Environmental History of the Twentieth Century* (London, 2000), 38–43, 212–16, 276–81; D. Worster, *Dust Bowl: The Southern Plains in the 1930s* (New York, 1979); A. G. Zarrili, 'Capitalism, Ecology, and Agrarian Expansion in the Pampean Region, 1890–1950', *Environmental History*, 6 (2001), 561–83.

³⁴ P. Zemyatchenskii, 'Velikoanadol'skii uchastok', *Trudy Ekspeditsii, snaryazhennoi Lesnym Departementom, pod rukovodstvom professora Dokuchaeva, Nauchnii otdel*, 1, 3 (1894), 15, 17. For further descriptions of the dust storms on the steppes in the early 1890s, complete with 'before and after' illustrations, see N. Adamov, 'Meteorologicheskie nablyudeniya 1892–1894 godov', *Trudy Ekspeditsii, snaryazhennoi Lesnym Departementom, pod rukovodstvom professora Dokuchaeva, Nauchnii otdel*, 3, 1 (1898), 235–43. For a measured analysis, see G. Vysotskii, 'Materialy po izucheniyu chernykh bur v stepyakh Rossii', *Trudy Ekspeditsii, snaryazhennoi Lesnym Departementom, pod rukovodstvom professora Dokuchaeva, Sbornyi otdel*, 1 (1894), 1–16. For an account of sand storms on the steppes of the north Caucasus, see *Gosudarstvennyi Arkhiv Stavropol'skogo Kraia*, f.101, op.4, d.894, 19 Sept. 1880–5.

of the natural vegetation. Adamov was careful to point out that the effect of the wind on the steppes was far greater in the 1890s than the 1790s as a result of the changes made to the environment in the intervening century.³⁵ Other scholars have not been so measured in their analyses. Descriptions of dust storms on southern plains of the USA in 1830 (not 1930), prompted the historian James Malin to call the argument ‘that the dust storms of the 1930s were *caused* by “the plow that broke the Plains”’ a ‘brazen falsehood’.³⁶ Malin’s assertion has, of course, been disputed, by Donald Worster amongst others.³⁷ The problem for environmental scientists and historians is to distinguish between phenomena that occur independently of human actions, and those that are caused or exacerbated by the changes made by people. Such debates continue among environmental scientists to the present day.³⁸

III

In Russia, over the course of the nineteenth century, an increasing number of landowners, scientists, government officials and other educated people made a connection between the changes the settlers had made to the land, especially but not solely the destruction of the small areas of woodland on the steppes, and the droughts, which seemed to be recurring more frequently and with ever more disastrous consequences. Such views were often expressed in the wake of serious droughts, such as that of 1832–3,³⁹ and built up momentum over the following decades. With increasing vigour, it was asserted and reasserted in the specialist and more general periodical press that, as a result of deforestation and other human activity, the climate was becoming drier, droughts more frequent and the drying influence of the hot winds from Asia (the *sukhovei*) more marked as the woods that that had sheltered the land were destroyed.⁴⁰ In the autumn

³⁵ Adamov, ‘Meteorologicheskie nablyudeniya 1892–1894’, 235.

³⁶ J. C. Malin, ‘The Grassland of North America: Its Occupance and the Challenge of Continuous Reappraisals’, in *Man’s Role in Changing the Face of the Earth*, ed. William L. Thomas (2 vols., Chicago, 1956), II, 355–6.

³⁷ Worster, *Dust Bowl*, 205–6.

³⁸ See, for example, W. B. Meyer, *Human Impact on the Earth* (Cambridge, 1996), 201–15.

³⁹ See ‘Russuzhdenie o neobkhodimosti okhraneniya vladel’cheskikh lesov ot istrebleniya i o pol’ze pravil’nogo lesnogo khozyaistva’, *Lesnoi zhurnal*, pt 1, bk 1 (1833), 51–103; Breitenbakh, ‘O pol’ze lesov v prirode’, *Lesnoi zhurnal*, pt 1, bk 3 (1835), 383–91; ‘O vliyaniy lesov i istrebleniya onykh na klimat’, *Lesnoi zhurnal*, pt 1, bk 3 (1837), 427–42. On the drought and harvest failure of 1832–3, see D. Moon, *Russian Peasants and Tsarist Legislation on the Eve of Reform, 1825–1855* (Basingstoke and London, 1992), 41–4; J. R. Staples, *Cross-Cultural Encounters on the Ukrainian Steppe: Settling the Molochna Basin, 1783–1861* (Toronto, 2003), 87–92.

⁴⁰ For a few examples, see I. Palimpsestov, ‘Peremenilsya li klimat yuga Rossii?’, in *Sbornik statei o sel’skom khozyaistve yuga Rossii, izvlechennikh iz Zapisk Imperatorskogo Obshchestva sel’skogo khozyaistva yuzhnoi Rossii s 1830 po 1868 god*, ed. *idem* (Odessa, 1868), 1–35; [Valuev], *Doklad vysochaishe uchrezhdennoi komissii dlya issledovaniya nyneshnego polozheniya sel’skogo khozyaistva i sel’skoi*

of 1891, as the full extent of the catastrophe was becoming apparent, the agricultural specialist Nicholas Vereshchagin put words to the anxiety felt by many when he linked the 'harmful influence of the hot, Asiatic winds' with the devastating Mongol invasion of the thirteenth century.⁴¹ The hot, dry winds from Asia were the new Mongols. And such concerns were picked up by writers and artists, most famously by Chekhov in his play 'Uncle Vanya', completed in 1896. The character Dr Astrov makes an impassioned speech about the need to preserve the forests: 'Forests keep disappearing, rivers dry up, wild life's become extinct, the climate's ruined and the land grows poorer and uglier every day.'⁴² Some scientists, however, were more wary about making such direct, causal links between deforestation and climate change. In a debate in the Free Economic Society in late 1891, the meteorologist Alexander Voeikov noted that the available data did not seem to show a decline in the total level of precipitation. Dokuchaev, in his book *Our Steppes: Past and Present*, doubted that the climate was becoming drier, and also pointed to the lack of adequate information to support the argument that the climate was changing. Both scientists called for more funds to support research.⁴³

As the disaster of 1891–2 unfolded, Russians tried to find out what had caused it and what could be done to prevent repetitions. There was general agreement that the main cause was abnormal meteorological conditions. Future Minister of Agriculture Aleksei Ermolov gave a detailed account of the conditions that preceded the harvest failure in

proizvoditel'nosti v Rossii (Spb, 1873), 7, 41; V. Vasil'chikov, 'Chernozem i ego budushchnost', *Otechestvennye zapiski*, 2 (Feb. 1876), 2nd pagn, 167–82; D. L. Ivanov, 'Vliyanie Russkoi kolonizatsii na prirodu Stavropol'skogo kraia', *Izvestiya Imperatorskogo Russkogo Geograficheskogo Obshchestva*, 22, 3 (1886), 225–54; P. L. Korf, 'Po povodu neurozhaya nyneshnego goda', *Trudy Imperatorskogo Vol'nogo Ekonomicheskogo Obshchestva*, 2, 6 (1891), 203–21; V. Solov'ev, 'Narodnaya beda i obshchestvennaya pomosh', *Vestnik Evropy*, 10 (Oct. 1891), 781. See also O'Rourke, *Warriors and Peasants*, 50–5, 76–8. Russians were influenced by north American and western European scientists. See Georg Marsh, *Chelovek i priroda, ili o vliyaniu cheloveka na izmenenie fiziko-geograficheskikh usloviu prirody*, trans. from English by N. A. Nevedomskii (Spb, 1866); Bekkeral' [Becquerel], 'Vliyanie istrebleniya lesov na klimat', [review], *Zhurnal Ministerstva Gosudarstvennykh Imushchestv*, 52, 4 (1854), 54–68.

⁴¹ N. V. Vereshchagin, 'Po povodu neurozhaya tekushchego goda', *Trudy Imperatorskogo Vol'nogo Ekonomicheskogo Obshchestva*, 2, 5 (1891), 183. (He was the brother of the war artist Vasilii Vereshchagin, who had a growing distaste for the 'Orient'. D. Schimmelpenninck van der Oye, *Toward the Rising Sun: Russian Ideologies of Empire and the Path to War with Japan* (DeKalb, IL, 2001), 207–8.)

⁴² Anton Chekhov, *Five Plays*, trans. and with an Introduction by Ronald Hingley (Oxford, 1977), 127–8. See also J. Costlow, 'Imaginations of Destruction: The "Forest Question" in Nineteenth-Century Russian Culture', *Russian Review*, 62 (2003), 91–118.

⁴³ 'Besedy v I Otdelenii Imperatorskogo Vol'nogo Ekonomicheskogo Obshchestva po voprosu o prichinakh neurozhaya 1891 goda i merakh protiv povtoreniya podobnykh urozhayev v budushchem', *Trudy Imperatorskogo Vol'nogo Ekonomicheskogo Obshchestva*, 1 (1892), 110, 121–2, 124. See also A. Voeikov, 'Po voprosu lesnoi meteorologii', *Meteorologicheskii vestnik*, 2 (1892), 51–60; Dokuchaev, *Sochineniya*, VI, 88–9.

a book published in early 1892. The unusual weather began in 1890. The first half of the summer was very wet. The rain was so heavy that many rivers burst their banks in early June. The weather changed sharply, however, in the second half of the month. There followed a 'tropical' heatwave, drought and scorching hot winds from the south-east. As a result, the harvest in 1890 was adversely affected, and in many places the sowing of the winter crops was delayed until late September or early October. Winter began early. There were hard frosts in late October and early November. When the snow came, it was accompanied by strong winds that blew it around in snow storms and, crucially, denuded the fields of the snow cover needed to protect the winter crops. In the spring of 1891, consequently, there was little water in the rivers and no floods that usually irrigated the meadows. Nevertheless, the fields absorbed sufficient moisture from what melting snow there was to allow the spring crops to be sown as usual, and the winter crops began to recover. The turn for the better was short-lived, however. In late April and May, the weather swung from cold snaps and hard frosts to heat waves and droughts and then back again. The young crops could not survive such conditions: the arable fields remained bare, and meadows were scorched and yellow. Moreover, trees dried up and died in dozens and even weeds shrivelled and died. The drought continued for much of the summer. The worst affected was the area around Tsaritsyn (later Stalingrad) on the lower Volga, where there was no rain for ninety-six days: over three months. Large parts of the steppes received no rain for two months. The effects of the drought were exacerbated by the return of the scorching winds from the east, that dried out the parched topsoil even more, and then blew it around in dust storms similar to those described earlier. The land was drying out not just on the surface, but also underneath. Ground water levels fell; ponds, springs and wells dried up; rivers were lower than usual.

And the harvest failed. In the seventeen provinces of the south and south-east worst affected, the harvest was down by 45.4 per cent compared with average harvests in 1883-7. The most badly hit provinces were Orenburg, in the east of the steppe region, where the shortfall was 73 per cent, and Voronezh, on the boundary of the open steppe and forest-steppe, where it was 69 per cent down. The disaster hit roughly one third of European Russia. The steppes of southern Ukraine, part of the Don and the North Caucasus, however, escaped the drought and had good harvests in 1891. They were not enough to compensate. In the fifty provinces of European Russia as a whole, the total grain harvest was 26 per cent below the average for the years 1883-7.⁴⁴ Although conditions in the atmosphere were held largely responsible for the disaster, the role

⁴⁴ [A. S. Ermolov], *Neurozhai i narodnoe bedstvie* (Spb, 1892), 3-34. (The book was published anonymously, but the author was recognised as A. S. Ermolov. *Novyi Entsiklopedicheskii Slovar'*, ed. F. A. Brokgauz and I. A. Efron (Spb, n.d.), xvii, 514-15.) See also M. N. Raevskii,

of other factors, such as agricultural practices, the system of communal land tenure and indeed the wider social and economic system were also discussed. And, scientists agonised over whether human impact on the meteorological environment was also to blame.⁴⁵

At the same time, many schemes were put forward to seek to deal with the environmental constraints on arable farming on the steppes, and so avert future disasters. One of the most comprehensive was that of Ermolov, which he published in early 1892.⁴⁶ Ermolov's plan, together with others put forward, built on previous plans and experience. The most widely proposed solutions were conservation of existing woodland, tree planting and artificial irrigation. While deforestation was believed by many to have a detrimental impact on the climate, making it drier and more extreme, conservation and planting more trees was thought to have the opposite effect. Many specialists added that trees sheltered the land from the hot, dry winds from Asia, and assisted in moisture retention in the soil.⁴⁷ Early tree-planting schemes on the steppes met with mixed success, as the saplings struggled to overcome droughts, the salty subsoil and pests.⁴⁸ By the latter part of the century, however, much experience had been accumulated in steppe forestry. An important centre of research was the Velikii Anadol'skii plantation, which had been founded in 1843 on the open steppes of Ekaterinoslav province near the Sea of Azov.⁴⁹

The second main solution proposed to deal with the shortage of moisture on the steppes was artificial irrigation. Many books and pamphlets advocating irrigation were produced. Most involved damming gulleys and ravines to store water from rain and melted snow, which was then to be released to irrigate the fields. It proved much harder to put the

⁴⁵ 'Neurozhai 1891 goda v svyazi s obshchei kharakteristikoi nashei khlebnoi proizvoditel'nosti a takzhe vyvoza khlebov zagranitsu za pred"idushchie gody', *Izvestiya Imperatorskogo Russkogo Geograficheskogo Obshchestva*, 28, 1 (1892), 1–29; N. Kravtsov, 'Po povodu neurozhaev v 1891 i 1892 godakh', *Sel'skoe khozyaistvo i lesovodstvo* (Apr. 1893), 1st pagn, 317–35.

⁴⁶ See 'Besedy v I Otdelenii Imperatorskogo Vol'nogo Ekonomicheskogo Obshchestva'.

⁴⁷ [Ermolov], *Neurozhai*, 34–78. See also P. Barakov, *O vozmozhnykh merakh bor'by s zasukhami* (Odessa, 1892); P. A. Kostychev, *O bor'be s zasukhoi v chernozemnoi oblasti postredstvom obrabotki polei i nakopleniya na nikh snega* (Spb, 1893).

⁴⁸ See P[alimpsestov], 'Lesovodstvo. Nechto v rode "Vvedeniya" v uroki lesovodstva dlya Novorossiiskogo kraia', *Zapiski Imperatorskogo Obshchestva Sel'skogo Khozyaistva Yuzhnoi Rossii*, 1 (Jan. 1852), 15–80; Vasil'chikov, 'Chernozem i ego budushchnost'; Ya. Veinberg, *Les: znachenie ego v prirode i mery k ego sokhraneniyu* (Moscow, 1884). For a dissenting view, see P. A. Kostychev, 'Sposobstvuet li razvedenie lesov unichtozheniyu zasukh?', *Otechestvennye zapiski*, 3 (1876), 2nd pagn, 1–33.

⁴⁹ *GARO*, f.301, op.14, d.7, 1849–52; d.10, 1850; d.22, 1852–60.

⁴⁹ N. G. Rachinskii, 'O stepnoe drevovozrashchenii v Novorossiiskom krae po povodu preobrazovaniya Veliko-Anadolskogo lesnichenstva', *Zapiski Imperatorskogo Obshchestva Sel'skogo Khozyaistva Yuzhnoi Rossii* (1865), 426–38; G. N. Vysotskii, 'Stepnoe lesorazvedenie', in *Pohnaya entsiklopediya russkogo sel'skogo khozyaistva i soprokasayushchikhysya s nimi nauk* (11 vols., Spb, 1900–9), IX, 443–99.

schemes into practice. Some private landowners built irrigation schemes, but they were usually restricted to providing water for people, cattle, vegetables and orchards.⁵⁰ In the 1880s, in the wake of serious droughts and harvest failures in Samara province on the Volga, the Ministry of State Domains put Lieutenant-General I. I. Zhilinskii in charge of an expedition to investigate irrigating the steppes. Supplying water for the use of livestock and humans, and irrigating low-lying meadows proved much easier and cheaper than irrigating arable fields.⁵¹ Nevertheless, a programme of public works to irrigate the steppe region was planned on the eve of the disaster and put into operation under General Annenkov in 1892. Dokuchaev was one of the technical advisors. The programme was not a great success, however, and Annenkov was charged with misuse of the funds allocated to him.⁵²

Dokuchaev's work in the aftermath of disaster of 1891–2, including his plan to address the environmental constraints on arable farming on the steppes, thus did not come out of the blue but, as he readily acknowledged, was part of a larger body of theoretical and practical work by his contemporaries and predecessors.⁵³

IV

Vasilii Dokuchaev is one of the major figures in nineteenth-century Russian, and world, science; he is on a par with the chemist Dmitrii Mendeleev, who drew up the periodic table of elements. Educated in the natural sciences at St Petersburg University, Dokuchaev went on to conduct pioneering work in geomorphology, geology and, above all, soil science. He devoted a great deal of time and energy to organising and leading scientific expeditions, and was committed to applying science to the problems experienced by agriculture in late nineteenth-century Russia.⁵⁴ His early work, in the 1870s, concerned the formation of ravines

⁵⁰ A. Bode, 'O dobyvanii vody v stepnykh mestakh yuzhnoi i yugo-vostochnoi chasti Evropeiskoi Rossii', *Zhurnal Ministerstva Gosudarstvennikh Imushchestv*, 9 (1843), 4th pagn, 141–5; *GARO*, f.46, op.1, d.780 (1866–9); S. Kizenkov, 'Oroshenie', in *Polnaya entsiklopediya russkogo sel'skogo khoziaistva*, VI, 414–68.

⁵¹ I. I. Zhilinskii, *Ocherk rabot ekspeditsii po orosheniyu na yuge Rossii i Kavkaze* (Spb, 1892); *idem*, *Zemledel'cheskie gidravlicheskie raboty* (Spb, 1893), 21–39. See also M. N. Gersevanov, 'Ob obvodnenii yuzhnoi stepnoi polosy Rossii', *Zapiski imperatorskogo russkogo tekhnicheskogo obshchestva* (Jan. 1891), 1st pagn, 1–30.

⁵² *Stenograficheskii otchet o soveshaniiaakh pri [Imperatorskom Moskovskom] Obshchestve [Sel'skogo Khoziaistva], s 18-go po 22-e Dekabria 1892 goda, po obshchestvennym rabotam po obvodneniu yugo-vostochnoi chasti Rossii, proizvennym v 1892 g. rasporyazheniem Zaveduiushchego Obshchestvennymi rabotami Generala M. N. Annenkova*, ed. A. P. Perepelkin (Moscow, 1893); Robbins, *Famine*, 110–12.

⁵³ Dokuchaev, *Socheniniya*, VI, 105.

⁵⁴ On his career, see L. A. Chebotareva, 'Vasilii Vasil'evich Dokuchaev (1846–1903). Biograficheskii ocherk', in Dokuchaev, *Socheniniya*, IX, 49–152; G. V. Dobrovolskii,

and river valleys. He challenged catastrophist theories, and emphasised the role of erosion caused by flowing water over the long term.⁵⁵ In the mid-1870s he turned his attention to the study of soil, in particular the black earth of the steppes. The drought of 1875 prompted the Free Economic Society to fund Dokuchaev to carry out a detailed study of the black earth in the major agricultural regions of Russia. In 1883, he published his major work, *The Russian Black Earth*, in which he presented a detailed analysis of the geographical distribution of the black earth, its fertility and a comprehensive theory for its origins.⁵⁶ On the basis of this work, between 1882 and 1894, he led teams of scientists in expeditions to evaluate the soil and natural resources of Nizhnii Novgorod province, in the north of the black earth region, and Poltava province, in the heart of the black earth region in Ukraine.⁵⁷

Dokuchaev's work in Poltava province provided much of the material for his book *Our Steppes: Past and Present*.⁵⁸ It was in this book that Dokuchaev put forward his explanation for the long-term, natural and human-induced causes of the drought and harvest failure of 1891–2, and presented his plan to address the problems. At the heart of the book is the question of moisture, which was crucial to the success of agriculture on the steppes, and the lack of which in 1891 had caused the disaster. The book took the form of a series of chapters on different aspects of the environment of the steppes (geology, hydrology, soil, flora, fauna, climate). Most chapters described the natural processes involved in the evolution of the steppe environment since the end of the last ice age. He also described the later human impact on that environment. He allowed little or no role for human activity in the formation of the steppe environment, which, therefore, for Dokuchaev was a 'virgin' (*deustvennyi*) or natural environment. Human impact came towards the end of Dokuchaev's story. In examining the effects of human actions, he paid particular attention to the felling of much of the small amount of natural woodland in river valleys and other specific parts of the region, to the removal of much of the original vegetation, in particular the steppe grasses, and the destruction of the structure of the black earth by wholesale ploughing. (Ploughing, but not grazing, destroys the structure of the soil.) Dokuchaev, who had

'Vsya zhizn' v nauke i bor'be', in V. V. Dokuchaev, *Dorozhe zolota russkii chernozem*, ed. G. V. Dobrovolskii (Moscow, 1994), 5–44; Krupenikov and Krupenikov, *Puteshestviya*.

⁵⁵ V. V. Dokuchaev, 'Ovrage i ikh zhachenie', in Dokuchaev, *Sochineniya*, I, 103–11 (1st published in *Trudy Vol'nogo Ekonomicheskogo Obshchestva*, 3, 2 (1877), 167–78); *idem*, 'Sposoby obrazovaniya rechnykh dolin Evropeiskoi Rossii', in *Sochineniya*, I, 113–273, esp. 153–73 (1st published in *Trudy S.-Peterburgskogo obshchestva estestvoisp.*, 9 (1878), 1–222).

⁵⁶ Dokuchaev, *Sochineniya*, III (1st published as *Russkii chernozem: Otchet Imperatorskomu Vol'nomu Ekonomicheskogo Obshchestva* (Spb 1883)).

⁵⁷ Krupenikov and Krupenikov, *Puteshestviya*, 31–82.

⁵⁸ Dokuchaev, 'Nashi Stepi'.

visited the home of the late writer Gogol' at Dikan'ka in Poltava province in 1888, bemoaned the disappearance of the 'virgin steppe' that the writer had lauded and made famous.⁵⁹

The loss of the natural vegetation of the steppes and ploughing up the black earth had all led, he argued, to very serious consequences. Virgin soils and land covered by virgin steppe grasses, together with the larger areas of woodland that had previously existed, were, he argued, better able to absorb and retain moisture from melted snow and rain. Ploughed soil and cultivated or mown land, on the contrary, were more liable to lose moisture through evaporation and run-off. Ploughing and cultivation, moreover, exacerbated soil erosion and gulleying. These, in turn, further increased the drainage of water – along the enlarged gulleys and into the rivers – that would otherwise have been retained and absorbed into the land. The consequence of all these, he maintained, was that ground water levels were falling and the steppes were gradually drying out. This drying out of the land made crops more vulnerable to the periodic droughts that afflicted the steppes. He pointed to evidence that 'virgin' (*tselinnii*) land was better able to support vegetation, including fodder grasses, even in 'extraordinarily dry years' when artificial meadows or land that had been previously ploughed and left fallow for a few years, yielded no hay. For Dokuchaev, therefore, the crop failure of 1891 was explained by the drying out of the land.⁶⁰ Dokuchaev thus presented his interpretation of the history of the evolution of the natural environment of the steppes and the impact of human activity. And it was the latter, which in his view had upset 'virgin' nature, to which he attributed the harvest failure of 1891.

Dokuchaev's conclusions were supported by the work of a colleague and close friend, A. A. Izmailovskii, who was involved in a research project investigating the 'drying out of the steppe'. In the 1880s and 1890s Izmailovskii conducted field work in Kherson and southern Poltava provinces, in Ukraine. Like Dokuchaev, Izmailovskii argued that the alleged drying out of the steppe was due to the removal of the 'virgin' vegetation and ploughing up the land. The two scientists became acquainted during Dokuchaev's expedition to Poltava province in the 1880s, and were influenced by each other's work.⁶¹ Thus, Dokuchaev and Izmailovskii dissented from the view of many of their contemporaries that the disaster of 1891 was a result of climate change, in particular the allegedly increasing frequency in droughts, that was in turn claimed to be

⁵⁹ Krupenikov and Krupenikov, *Puteshestviya*, 74, 77. Dokuchaev, *Sochineniya*, VI, 58.

⁶⁰ Dokuchaev, *Sochineniya*, VI, esp. 57–61, 87–9.

⁶¹ A. A. Izmail'skii, 'Kak vysokhla nasha step'. Issledovaniya otositel'no vlazhnosti pochvy i podpochvy', *Sel'skoe khozyaistvo i lesovodstvo: Zhurnal Ministerstva Gosudarstvennikh Imushchestv*, pt 173 (Aug. 1893), 2nd pagn, 267–89, pt 174 (Sept. 1893), 2nd pagn, 1–27. For their correspondence, see 'Iz perepiski s A. A. Izmailovskim (1888–1900)', in Dokuchaev, *Sochineniya*, VIII, 243–325.

a consequence of deforestation (see above). The two scientists maintained that it was the land, not the climate, that was changing and becoming drier.

V

Having outlined his interpretation of the long-term causes of the harvest failure of 1891, Dokuchaev went on to propose a series of measures to overcome the problems which were undermining agriculture in the steppe region which we can call 'The Dokuchaev Plan':

- I. Regulation of rivers – narrow and straighten courses of the major rivers, reduce spring floods, stop rivers silting up, reinforce banks with trees to stop sand etc. getting into rivers, remove sand bars; and dam smaller rivers and upper reaches of larger rivers to regulate flow and retain water in reservoirs.
- II. Regulation of ravines and gulleys – reinforce steep slopes with trees, ban ploughing on steep slopes and, where appropriate, dam them to create ponds to hold rain and melt water.
- III. Regulation of the use of water on the open steppes and watersheds – dig ponds on watersheds to hold melt and rain water and reinforce the banks with trees; elsewhere on the open steppes, plant hedges and build long, low dykes to help retain snow, melt and rain water; and plant trees on sandy soil, hillocks and other areas unsuitable for ploughing to act as wind breaks; dig wells to tap the replenished ground water for irrigation.
- IV. Work out norms for relative areas of arable land, meadows, forest and water in conformity with local climate, ground and soil conditions as well as local agriculture.
- V. Establish ways to cultivate the soil in order to make best use of the moisture, and work out the best varieties of crops to grow with regard to local soil and climatic conditions.⁶²

Dokuchaev recognised that points IV and V could not be implemented immediately and would require much more preparatory work, but stated that the first three were fully attainable and were matters of utmost urgency in the interests of the state.⁶³ He further recognised that the successful implementation of his plan required science, technology, state

⁶² The plan was published towards the end of Dokuchaev, 'Nashi stepi', and again in the introduction to the works of the scientific expedition that was set up to research the plan. Dokuchaev, *Sochineniya*, VI, 87–96, 112–18. For earlier proposals by others to regulate rivers, see GARO, f.46, op.1, d.590, 1857; I. Bentkovskii, 'Reka Kuma i neobkhodimost' uluchshit' ee ekonomicheskoe znachenie', *Stavropol'skie gubernskie vedomosti*, chast' neoffitsial'naya, 27–8 (1882).

⁶³ Dokuchaev, *Sochineniya*, VI, 90–2.

expenditure, and also good will, enlightened outlook and love of the land on the part of the landowners.⁶⁴ On the surface, Dokuchaev's plan seems broadly similar to other such plans proposed in and before 1892. Where it differs, however, is in his approach. His solutions were based on his interpretation of the long-term environmental history of the steppes, and sought to undo what he saw as the effects of human activity by working with natural processes in order to 'improve' the steppes for agriculture. According to one recent scientist, Dokuchaev's plan was, in present-day terminology, 'profoundly ecological' as well as 'talented propaganda'. Dokuchaev, moreover, was 'thirsting for action'.⁶⁵ Another difference between Dokuchaev's plan and others was that he received backing to put some of it into action.

VI

Dokuchaev tried, without success, to seek funding from the Free Economic Society, which had supported his study of the black earth.⁶⁶ Support was soon forthcoming from official sources. This is clear evidence for the grave concern that the drought and harvest failure had caused in official circles. The impetus for action seems to have come first from the provincial authorities in the steppe region. On 30 October 1891, the governor of Samara province reported to the minister of internal affairs on the seriousness of the drought and crop failure in his province. He identified irrigation and forestation as ways to avert such disasters in the future, and urged the minister to take steps to compel village communities and landowners, including the state and imperial family, to carry them out. He also called on the government to make the necessary technology and finance available in the form of loans. At a meeting of the Committee of Ministers in December 1891, the tsar himself noted the seriousness of the proposal. The committee referred the matter to the Ministry of State Domains, where it was passed to the Forestry Department of the Ministry. On 20 January 1892, the Department recommended finding out the following: how far and in what direction forestation of the steppes could influence crops, and the proportion of forest to steppe that would be necessary for a noticeable influence; how best to distribute new forests

⁶⁴ *Ibid.*, 102.

⁶⁵ I. A. Krupenikov, 'Ekspeditsii V. V. Dokuchaeva', *Pochvovedenie*, 2 (1996), 145.

⁶⁶ 'Zhurnal Obshchego Sobraniya Imperatorskogo Vol'nogo Ekonomicheskogo Obshchestva 19 May 1892', *Trudy Imperatorskogo Vol'nogo Ekonomicheskogo Obshchestva*, 1 (1893), 2nd pagn, 2; 'Otchet sekretarya o deistviyakh Imperatorskogo V. Ek. Obshchestva za 1892 g.', *Trudy Imperatorskogo Vol'nogo Ekonomicheskogo Obshchestva*, 3 (1893), 3rd pagn, 5. The Society did take a keen interest in the disaster, organising a temporary bureau to investigate the crop failure and holding a series of discussions that addressed the key issues.

on the steppe to achieve the desired goal; if any experiments would be needed to plan them, and, crucially, how much it would all cost.⁶⁷

In the spring of 1892, the Forestry Department invited Dokuchaev to a special meeting to discuss 'the development of forestation work with the aim of regulating the management of water resources on the steppes'. The meeting decided to carry out those parts of Dokuchaev's plan that involved planting trees in ravines, on the open steppe, around reservoirs, along rivers and on sandy areas. In order to carry out such work, field research stations were to be established on three plots of state land. A total of 21,300 roubles was to be assigned to cover the salaries and expenses of the head of the expedition, his assistants and other specialists, and the cost of hired labour, equipment and analysis of samples of soil and water. Dokuchaev was invited to lead the expedition.⁶⁸ On 22 May the Minister of State Domains, M. N. Ostrovskii, approved the creation of the 'Special Expedition for testing and costing various methods and approaches for management of forestry and water resources on the steppes of Russia under the leadership of Professor Dokuchaev' attached to the ministry's Forestry Department.⁶⁹

Dokuchaev put together a team of scientists to carry out the work. He appointed colleagues he had worked with on previous expeditions, for example N. M. Sibirtsev, and younger scientists who went on to greater importance, such as the forestry specialist G. N. Vysotskii and the botanist G. I. Tanfil'ev. He then reconnoitred and set up the three field research stations of around 5,000 hectares. He consulted Izmailovskii, and carefully selected sites which contained various combinations of typical features of the environment of the steppes. Dokuchaev chose plots, moreover, that were situated on watersheds, i.e. far from large rivers, in places with little water that regularly suffered from drought, strong winds and other 'unfavourable features of steppe nature'. The plots of land he selected were as follows: Starobel'skii (Derkulinskii) in eastern Khar'kov province, on the watershed between the Donets and Don rivers, which was an example of exposed, open steppe; Khrenovskoi in Voronezh province, between the Don and Volga river systems, which included areas of steppe as well as natural coniferous and broad-leaved woodland and was

⁶⁷ *Rossiiskii Gosudarstvennyi Istoricheskii Arkhiv*, f.1387, op.28, 1892, d.1023, ll.1–6. The Ministry had also received requests for action from local *zemstva*. Dokuchaev, *Sochineniya*, VI, 105–6. The Appanage Dept, which was responsible for the estates of the imperial family, also carried out anti-drought measures and experiments in 1891–2. *Meropriyatiya udel'nogo vedomstva v bor'bu s zasukhami i drugimi klimaticheskimi vliyaniyami, prepriyatstvuyushchimi khozyaistvu v yugo-vostochnykh stepnykh imenyakh* (Spb, 1893).

⁶⁸ Dokuchaev, 'Osobaya ekspeditsiya, snaryazhennaya lesnym departamentom, pod rukovodstvom professora Dokuchaeva', in *Sochineniya*, VI, 105–8, 118–19.

⁶⁹ Dokuchaev, 'Osobaya ekspeditsiya', 118; Chebotareva, 'Vasilii Vasil'evich Dokuchaev', 105–10.

thus an example of forest-steppe; and Veliko-Anadol'skii in Ekaterinoslav province, between the Donets and Dnepr rivers, which contained the famous forestry plantation on the open steppe.⁷⁰ The research stations contained agricultural land, forestry plantations and what Dokuchaev believed to be examples of the 'virgin' environment of the steppes, of which only small areas were left on account of wholesale ploughing. These examples were vital for Dokuchaev, because it was the 'undisturbed', virgin environment that he maintained was better able to retain moisture in the soil and support vegetation even in years with low rainfall (see above).

Dokuchaev's teams of scientists carried out detailed research into the relief, hydrology, soil and geology, meteorological conditions and flora and fauna of these samples of 'virgin' nature. Dokuchaev believed that the various component parts of the natural environment of the steppes were all linked together. Bore holes were dug, meteorological stations set up and detailed data on the weather collected, samples of soil and ground water were collected and sent for chemical analysis, painstaking fieldwork and lists of species of plants and animals were made. The botanist Tanfil'ev wrote a very detailed account of the 'limits of forests in southern Russia', on the basis of Dokuchaev's technique of determining past vegetation from analysis of the organic content of the soil. Tanfil'ev followed Dokuchaev in concluding that, with the exception of river valleys and a few other exceptional areas, the steppes had never been forested.⁷¹ The results of all this work were published in a number of volumes over the next few years.⁷² The data gathered were essential for assessing the impact of the experiments that the expedition was to carry out. Thus, the samples of 'virgin' nature were to serve as 'baselines', or controls, for scientific research into ways of overcoming the environmental constraints on agriculture on the steppes. Furthermore, the 'virgin' environment could provide models on which the scientists could draw to achieve this by seeking to emulate the natural conditions on cultivated land.⁷³

⁷⁰ Dokuchaev, 'Osobaya ekspeditsiya', 118–22. For correspondence with Izmailovskii, see *Sochineniya*, VIII, 306–12.

⁷¹ G. Tanfil'ev, 'Predely lesov na yuge Rossii', *Trudy ekspeditsii, snaryazhennoi Lesnym Departamentom, pod rukovodstvom professora Dokuchaeva, Nauchnyi otdel*, II, Geobotanicheskie i fenologicheskie issledovaniya i nablyudeniya, part 1 (1894). See also V. V. Dokuchaev, 'Metody issledovaniya voprosa, byli li lesa v yuzhnoi stepnoi Rossii', in Dokuchaev, *Sochineniya*, I, 336–68.

⁷² *Trudy Ekspeditsii, snaryazhennoi Lesnym Departamentom, pod rukovodstvom professora Dokuchaeva, Nauchnyi otdel*, 4 vols. (1894–8).

⁷³ Dokuchaev, 'Osobaya ekspeditsiya', 122–5. For more detail on Dokuchaev's ideas for his 'field research stations', see V. V. Dokuchaev, 'K voprosu ob organizatsii opytnykh (polevykh) stantsii v Rossii', in *Sochineniya*, VII, 165–8; *idem*, 'Chislo, mesto, osnovy i zadachi sel'skokhozyaistvennykh opytnykh stantsii', in *ibid.*, 169–76; *idem*, 'Mesto, chislo, zadachi i

The team of scientists then went on to carry out a wide range of experiments into ways of addressing the environmental constraints on agriculture in the steppe regions. They investigated which types of trees would grow best in different types of soil and other aspects of the steppe environment by drawing on the experience of existing plantations, in particular Velikii Anadol'skii, as well as planting different species themselves and monitoring the results. They discovered that oak and birch followed by apple and pear trees grew best. Further experiments were carried out into different methods of planting trees. In 1893–5, Dokuchaev and his team planted around 100 hectares of trees to form shelterbelts to protect the exposed steppe of the Starobel'skii field research station from the drying influence of the wind. More trees were planted on the sides of ravines and gulleys to reinforce them and prevent further soil erosion. Tree planting was used as a way preventing dust storms, such as those in the spring of 1892 described earlier. In addition, experiments were carried out into ways of retaining, and if possible increasing, the available moisture in the soil that was so badly needed by farmers on the steppes. To this end, dams were built across ravines and gulleys so that they could serve as reservoirs. Ponds were dug for the same purpose. And trees were planted around the reservoirs and ponds to reinforce the sides and create shade to reduce evaporation. To investigate a further way of increasing the available moisture belts of trees were planted to retain snow that would otherwise have blown away and to reduce the run-off of rain water. They then monitored ground water levels, to ascertain whether they were increasing as a result of more water seeping into the land rather than drain away through gulleys and rivers. Wells were then dug to extract water from underground. The scientists also experimented with irrigation schemes, but their research stations contained few areas with the appropriate conditions for irrigating arable fields. Attempts to regulate the course of rivers came up against the interests of private landowners across whose land the rivers flowed.

Further experiments were carried out to ascertain the agricultural methods and crops that were most appropriate to the environmental conditions of the steppes. In particular, they were seeking to find those that would make the best use of the available moisture. Dokuchaev was particularly interested in working out the most appropriate balance between different types of land use: woodland, water, meadows, arable land, etc. He suggested that it would be advantageous to expand the area of land devoted to meadows, i.e. land with cultivated fodder grasses, that were closest to the wild steppe grasses that Dokuchaev believed to be the natural vegetation of the steppes. The implication of this, of course, was

osnovy reorganizatsii nashikh sel'skokhozyaistvennykh shkol i tak nazyvaemykh opytnykh stantsii', in *ibid.*, 177–81.

that raising livestock – the main occupation of the steppe nomads who had lived in the region for millennia – was more appropriate to the steppe environment than growing crops, which the more recent peasant settlers were relying on to sustain themselves.

The results of all these experiments were carefully monitored. The scientists compared the results with the control environments, and compared the different experiments. For example, they compared the harvests in fields protected by shelterbelts with those which were left open to wind, and in fields near to ponds and reservoirs with those that were further away from surface water. Some of the results, for example on the exposed steppe in Starobel'skii, suggested that Dokuchaev and his team had indeed found ways of 'improving nature' and making agriculture more viable on the steppes.⁷⁴ Thus, Dokuchaev seems to have attained some success in his approach of investigating the natural conditions over a long period of time, and then using them as guides to work out appropriate ways to work the land in ways that would provide a basis for agriculture to flourish with less risk from the periodic droughts and causing less damage to the environment. This approach reflected Dokuchaev's deep respect for nature. He was a pioneer, therefore, of what today would be termed 'sustainable development'.⁷⁵

Dokuchaev's ambitious plan was not, however, carried out in its entirety. In part this was a result of the enormous financial outlay that it would have entailed. Dokuchaev, moreover, had other matters to deal with in the 1890s as his expertise was much in demand. In the summer of 1892 the Ministry of National Education appointed him to reorganise the Novo-Aleksandriiskii Institute for Agriculture and Forestry in Lublin province in Russian Poland. He resigned as the leader of the expedition to the steppes in 1897, partly as a result of health problems, from which he never fully recovered. Dokuchaev died prematurely in 1903.⁷⁶ The work of the scientists whom Dokuchaev appointed to work on the expedition carried on, however, and some went on to have prominent careers.⁷⁷

⁷⁴ Dokuchaev, 'Osobaya ekspeditsiya', 145–60; *idem*, 'Soobshcheniya o lektsiyakh V. V. Dokuchaeva "Ob osnovakh sel'skogo khozyaistva"', in *Sochineniya*, VII, 216–26; *Trudy Ekspeditsii, snaryazhennoi Lesnym Departamentom, pod rukovodstvom professora Dokuchaeva, Otdel prakticheskikh rabot*, 3 vols. (1894–8). See also Krupenikov and Krupenikov, *Puteshestviya*, 85–99; E. S. Pavlov, 'Zashchitnoe lesorazvedenie v rabotakh ekspeditsii V. V. Dokuchaeva', in *Tezisy dokladov*, ed. V. K. Savost'yanov, I, 35–7.

⁷⁵ See J. D. Oldfield and D. J. B. Shaw, 'Revisiting Sustainable Development: Russian Cultural and Scientific Traditions and the Concept of Sustainable Development', unpublished paper presented to BASEES annual conference, Apr. 2002.

⁷⁶ Chebotareva, 'Vasilii Vasil'evich Dokuchaev', 105, 109–17, 149–50; Krupenikov and Krupenikov, *Puteshestviya*, 96, 101.

⁷⁷ For a list of works published by the scientists involved in expedition on related topics down to 1906, see 'Perechen' rabot po lesnomu opytному delu, opublikovannykh v Trudakh Ekspeditsii, snaryazhennoi Lesnym Departamentom, pod rukovodstvom

VII

How much of Dokuchaev's work on the environment of the steppes has stood the test of time and the rapid progress made by environmental sciences since the 1890s? He is still revered among scientists in Russia.⁷⁸ With regard to the ideas expressed in his book *Our Steppes: Past and Present*, subsequent research has tended to support his scepticism about a connection between deforestation and precipitation, and his emphasis on soil moisture and ground water. Scientists still dispute the impact of clearing woodland and ploughing the soil on water flows and runoff, however, which were so crucial to Dokuchaev's argument.⁷⁹ Where he was almost certainly wrong was in considering the environment of the areas of unploughed steppe he encountered in the late nineteenth century to be a natural or 'virgin' environment and, by extension, his belief that human impact on the steppes had occurred to a significant extent only in the recent past. Studies of fossil pollen in the steppe region have shown that, between around 7,000 and 5,000 years ago, long before Herodotus's visit and description of the treeless steppes, there had been much more extensive tree cover on the steppes, far to the south of the more recent southern boundary of the forest-steppe. Recent studies have also shown that human impact, for example the use of fire to clear woodland for pasture and arable farming, together with natural climate change, led to the creation of the more recent, largely treeless, steppes.⁸⁰ Paradoxically, Dokuchaev's plan, greatly distorted, became the basis for massive intervention in the environment in the late 1940s and early 1950s as the 'Stalin Plan for the Transformation of Nature' that

professora Dokuchaeva i v Trudakh Opytnykh Lesnichestv', in *Trudy po lesnomu opytному delu v Rossii. Otchet po lesnomu opytному delu za 1906 god* (Spb, 1907), 59–63; 'Perechen' rabot po lesnomu opytному delu, opublikovannykh v raznykh izdaniyakh', in *Trudy po lesnomu opytному delu v Rossii. Otchet po lesnomu opytному delu za 1907 god* (Spb, 1908), 162–5. See also S. V. Zonn and A. N. Eroshkina, 'Ucheniki i nasledovateli V. V. Dokuchaeva', *Pochvovedenie*, 2 (1996), 124–38.

⁷⁸ For example, a special scientific conference was held in 1992 to mark the centenary of his plan. *Tezisy dokladov*, ed. V. K. Savost'yanov, and a special issue of the major Russian soil science journal *Pochvovedenie* was dedicated to Dokuchaev in 1996 on the 150th anniversary of his birth.

⁷⁹ Meyer, *Human Impact on the Earth*, 5, 63, 118, 201–6.

⁸⁰ See M. I. Neishtadt, *Istoriya lesov i paleogeografiya SSSR v goltsene* (Moscow, 1957); *Zapovedniki*, ed. Stroganova, 26–7; P. E. Tarasov *et al.*, 'Present-day and Mid-Holocene Biomes Reconstructed from Pollen and Plant Macrofossil Data from the Former Soviet Union and Mongolia', *Journal of Biogeography*, 25 (1998), 1029–53; C. V. Kremenetski, O. A. Chichagova and I. N. Shishlina, 'Palaeoecological Evidence for Holocene Vegetation, Climate and Landuse Change in the Low Don Basin and Kalmuk Area, Southern Russia', *Vegetation History and Archaeobotany*, 8 (1999), 233–46.

envisaged planting massive shelterbelts across the steppes and vast dams and irrigation schemes.⁸¹

More in keeping with the spirit of Dokuchaev's work was his role as one of the pioneers of strict, scientific nature reserves (*zapovedniki*), where 'models of nature' (*etalony*) are preserved under inviolable management to exclude human activity other than carefully controlled scientific research. In the wake of his field research stations, a network of such nature reserves was established throughout Russia and the Soviet Union, and continues to exist at the present time.⁸² A new nature reserve on the steppes was established in the south-east of Rostov region in 1996.⁸³ More recent ideas about the role of humans in the creation of environments previously thought to be completely 'natural' have led to newer, scientific rationales for the reserves.⁸⁴

Dokuchaev was right, of course, to emphasise the impact of arable farming on the environment of the steppes. The area of land in the steppe region ploughed up for cultivating crops expanded considerably in the twentieth century as a result of Soviet agricultural policy. Even parts of the steppe nature reserves that had never been ploughed were ploughed up for cultivation and thus lost to science.⁸⁵ Khrushchev's virgin land campaign of the 1950s is best known for the ploughing up of former nomadic pasture land in Kazakhstan, but underutilised and marginal land in the steppes of the European part of the Soviet Union was also ploughed up, and shared the consequences of erosion and dust storms in the early 1960s.⁸⁶ The far greater use of chemical fertilisers in recent decades has also had a profound impact on the land. A new study of the black earth of the steppe region was conducted by scientists to mark the

⁸¹ V. A. Kovda, *Velikii plan preobrazovaniya prirody* (Moscow, 1952). On the link with Dokuchaev's work, see I. V. Tyurin, 'Ot redaktsii', in Dokuchaev, *Sochineniya*, vi (1951), 6–12; Zonn and Eroshkina, 'Ucheniki i nasledovateli V. V. Dokuchaeva', 130. See also P. Josephson, *Industrialized Nature: Brute Force Technology and the Transformation of the Natural World* (Washington, DC, 2002), 27–40.

⁸² V. E. Boreiko, 'Starobel'skii stepnoi zapovednyi uchastok, vydelennyi V. V. Dokuchaevym, – sushchestvyet!', *Stepnoi Byulleten'*, 2 (1998) (www.ecoclub.nsu.ru/books/Step-2/step2-20.htm, accessed 19 Apr. 2003); F. Shtilmark, *The History of Russian Zapovedniks, 1895–1995*, trans. G. H. Harper (Edinburgh, 2003), 10–13; I. Vorob'ev, 'Idei Dokuchaeva i territorial'naya okhrana stepei', *Stepnoi Byulleten'*, 15 (2004) (www.ecolab.nsu.ru/books/Step-15/02.htm, accessed 13 Oct. 2004). See also D. R. Weiner, *Models of Nature: Ecology, Conservation and Cultural Revolution in Soviet Russia*, 2nd edn (Pittsburgh, PA, 2000); *idem*, *A Little Corner of Freedom: Russian Nature Protection from Stalin to Gorbachev* (Berkeley, CA, 1999).

⁸³ V. A. Minoranskii and A. V. Chekin, *Gosudarstvennyi stepnoi zapovednik 'Rostovskii'* (Rostov-on-Don, 2003). The present author visited the reserve with a party of botanists from the Rostov-on-Don botanical gardens in the summer of 2003.

⁸⁴ See Weiner, *A Little Corner of Freedom*, 374–401.

⁸⁵ *Ibid.*, 93–103, 130.

⁸⁶ M. McCauley, *Khrushchev and the Development of Soviet Agriculture: The Virgin Land Programme 1953–1964* (New York, 1976).

hundredth anniversary of the publication of Dokuchaev's book on the black earth in 1983. The study showed that the levels of organic matter in the black earth, which gave it its legendary fertility, had fallen sharply, and the old problems of erosion and shortages of moisture remained. A new plan to combat these problems by rational usage was proposed.⁸⁷ A more recent study, however, indicates that the problems have not been addressed and erosion remains a serious problem.⁸⁸ The latest of the long succession of periodic droughts that have punctuated the environmental history of the Russian steppes hit the Don and the North Caucasus in the spring 2003 and caused a serious shortfall in the harvest in some areas. This latest steppe drought and harvest failure was witnessed by the present author who spent the spring and summer of 2003 on a research visit to the steppes.

⁸⁷ *Russkii chernozem: 100 let posle Dokuchaeva*, ed. V. A. Kovda and E. M. Samoilova (Moscow, 1983).

⁸⁸ Anatoly Greshnevikov, *Ukhodit pochva iz-pod nog* (Moscow and Rybinsk, 2002).