Toward a Joint Future beyond the Iron Curtain East–West Politics of Global Modelling

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Chapter 5

Toward a Joint Future beyond the Iron Curtain

East–West Politics of Global Modelling

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This chapter argues that computer-based global modelling produced particular long-term horizons which played an important, transformative role in Soviet governance by opening it up to East–West cooperation. Global modellers conceptualized the planet as a complex, interconnected system, the understanding of which required transnational scientific cooperation, enabling both scientists and data to cross national boundaries and Cold War divisions.[1] In turn, Soviet scientists forged and used the idea of the long-term future of the world to reveal and criticize problems being experienced, but not always acknowledged, in the Soviet Union. A history of computer-based global modelling is, therefore, a history of intertwining globalization, the transformation of the Soviet regime, and East–West transfer.

The first computer-based global models of social and economic development were produced under the auspices of international organizations, which brought together individuals from the Eastern and Western blocs: the Club of Rome, the United Nations agencies and, most importantly, the first international think tank, the International Institute for Applied Systems Analysis (IIASA) in Austria.[2] Although historians habitually use references to these international organizations as examples of the emergence of global governance, we still lack empirical knowledge about the professional networks that formed the framework of these organizations and the concrete projects that were pursued there.[3] This chapter fills this gap in knowledge by examining several cases of East–West cooperation in computer-based global modelling carried out through IIASA and the United Nations (UN).

But what is global modelling? Indeed, global modelling refers to a great many different concepts and techniques, which could be digital or analogue, purely conceptual or calibrated to run on particular computers. This chapter focuses on computer-based global modelling, a phenomenon that so far has been overlooked in histories of computing, although the impact of computer-based global modelling on modern governmentality cannot be overestimated.[4] First, global models encouraged policy makers to look farther ahead and evaluate present-day policies in the light of their long-term consequences. Even when computer power was quite limited, the idea of computer-assisted long-term planning commanded authority. Thus in 1961 the United Nations adopted the resolution Planning for Economic Development, which called for long-term projection and planning of the world economy.[5] Second, to be able to plan for the long-term became synonymous with being an advanced, post-industrial state, and the foremost tool for this kind of planning was a computer. In line with Peter Galison and Bruce Hevly, I suggest that being an expensive undertaking, requiring huge investment in computer technologies and transnational cooperation in collecting and sharing data, global modelling was part of Big Science and, as such, a symbol of state power.[6]

Another important aspect of global modelling is its connection to a very particular social world. Global computer models were traditionally associated with the small and closely-knit teams that created them. As a result, this technology could not be easily decoupled from its producers: the majority of models could not be easily reproduced or circulated through anonymous channels. Unlike computer hardware, the blueprints of which could be stolen through espionage, transferred and reproduced in another context, computer software for global modelling often had to be co-produced through face-to-face collaboration in order to be transferred. This is because the ability to use global models depended on almost tacit knowledge of particular systems. As a result, computer modelling platforms were disseminated through personal connections among the modellers.[7] Hence the history of global modelling is also a story of the emergence and spread of particular informal groups of both scientists and policy-makers. These often informal groups of global modellers were probably too loose and ad hoc to be described as transnational communities, but they certainly could be understood as distinct thought collectives, mobilized by their aim to produce a new type of science, global modelling.[8]

This chapter discusses several such thought collectives, based at the Computer Centre and the All-Union Institute for Systems Research (VNIISI) of the Soviet Academy of Sciences in Moscow. Both the Computer Centre and VNIISI were strongly anchored in international networks through the United Nations and the Institute of Applied Systems Analysis in Laxenburg, Austria. In what follows, I briefly review the origins of global modelling in the Soviet Union and the West. Then I proceed to describe the development of several international nodes, by which I mean ad hoc, temporary constellations of technology, scientists and political rationales, which enabled Soviet and Western scientists to co-produce a new, long-term and global future.

How to Join Capitalist and Communist Futures

How could it be possible to accommodate capitalist and communist futures in one world model? Did not the communist future exclude capitalism by default? The case of global modelling clearly shows that technology has its own politics that are able to transform existing ideological systems. Global modelling was based on mathematical methods and computer technology and as such belongs to the exact sciences. But it also drew on universalism and global thinking, which have a long cultural and political history and offered a particularly powerful form to the idea of global interconnectivity, which became increasingly influential from the 1960s.

Computer-based global modelling derived its influence from a wider fascination with new technologies as tools of transformation of economies and societies. Such post-war innovations as computer technologies, cybernetics, and systems theory were described by Western commentators as drivers of deep changes in industry, society and the economy. In the late 1950s, such thinkers as Donald Michael in his *Cybernation: The Silent Conquest* (1962), and also Marshall McLuhan, conceptualized these changes as the third technological or cybernetic revolution. Daniel Bell, who was sceptical about many of the postulates about cybernation, later developed the theory of a post-industrial society, leading to the convergence of capitalist and communist regimes, as political ideology would be replaced with technical systems of control.[9] Bell's ideas had some basis in reality: struggling to develop their economy, the Soviets embraced Western science and technology, but the Soviets also fiercely rejected any possibility of convergence with capitalism. A discursive resolution to the problem of how to combine the communist project with Western technoscience was found in 1954, when Soviet philosophers adopted John Desmond Bernal's notion of a scientific-technical revolution (STR).[10] The British thinker Bernal not only espoused leftist principles, but also postulated that progressive science, including the scientific-technical revolution, was by its nature "incompatible with capitalism."[11] Drawing on Bernal's formula, the Soviets posited that although the scientific-technical revolution was identical in East and West, its effects were different: dogma said that the scientific-technical revolution alone could not solve class antagonism and ameliorate the negative effects of private capital ownership; therefore the communist system had nothing to fear.[12] In this way, the scientific-technical revolution was recognized on both sides of the Iron Curtain as a driver of universal change that produced a new future which could not be strictly divided into capitalist and communist camps.[13]

Indeed, what brought the communist and capitalist regimes together was not even the scientific-technical revolution per se, but the insight that economic growth, driven by the scientific-technical revolution, had complex global consequences. In a somewhat round-about way the idea of a worldwide scientific-technical revolution significantly changed the meaning of "global" in Soviet scientific and policy thinking. If, as archival documents show, Soviet economists used the notion of "global models" to name models of the national economy in the 1960s, a decade later in the 1970s the notion of "global" economic models was used to refer to the world economy.[14] At the same time, Soviet international relations theorists used the word "globalism" to designate US ambition for the world hegemony. Accordingly, in Soviet international relations discourse, the word "global" was charged with negative undertones.[15] A completely different use of the term "global" emerged in Soviet geophysical sciences, where scholars used "global" to describe planetary processes as early as the 1950s. I suggest that it was through computer modelling that this geophysical notion of the "global" eventually migrated into Soviet economic and, at a later stage, political discourses. The culmination of Soviet global thinking was reached in 1985 when the notion of "global problems" was used for the first time to describe world issues in the official documents of the Congress of the Communist Party.[16]

The contention that the global system referred to a phenomenon that should be understood as both natural, that is, geophysical, and man-made, that is, induced by the scientific-technical revolution, was actively promoted by a new type of actor on the stage of world politics: international organizations. The first impetus to computerize global, that is, planetary processes involving nature, economy and population, came from the Club of Rome, an international organization established by the Italian industrialist Aurelio Peccei. The Club of Rome linked members of state governments, industries and academia hailing from both East and West. In the early 1970s the Club of Rome commissioned the creation of a world model from the American engineer Jay Forrester and a group of researchers directed by the young Dennis Meadows at the Massachusetts Institute of Technology.[17] Consisting of five interacting blocks of agriculture, natural resources, pollution, population and capital, this model was used to demonstrate the power of relations between these different sectors. The key goal was to demonstrate that such relations existed and were strong, rather than to produce a reliable forecast; in fact, the latter was impossible because of the absence of robust and detailed empirical data.[18] It is important to note that in Meadows's model, the long-term dimension emerged as an unintended side effect: this model extrapolated the possible development of world economic growth until it obtained an interesting result, namely, a dramatic decline of the world economy, population and living standards in 2050. Publicized in the report *The Limits to Growth* (1972), the message was clear: the long-term effects of current developments had to be considered in order to avoid a disaster. If humanity wished to maintain its living standards in the future, the leading Western nations had to revise their consumption habits and accept the idea of no-growth.[19]

How did the Soviet Union, struggling to "catch up with and overtake" the West, react to The Limits to Growth? First of all, this report did not take the Soviets by surprise, because the Soviet government was already part of the network in which this study originated. The vice-chairman of the state committee of science and technology (GKNT) and son-in-law of Prime Minister Aleksei Kosygin, Dzhermen Gvishiani, was a member of the Club of Rome. In the early 1960s, Gvishiani first met Aurelio Peccei, then the head of Olivetti, during the latter's business trip to Moscow, and since then Gvishiani interacted regularly with Peccei, Alexander King of the OECD and other members of the Club.[20] This network was used to bring some innovative ideas to the Soviet Union before they were made public in West. Thus Gvishiani invited Forrester and Meadows to Moscow to present their World model in the winter of 1970. East-West scholars also met to discuss the theses and methodology that would be used in the study underlying The Limits to Growth in a seminar, organized in Italy in 1971.[21]

The very organization of the visit of Forrester's team to Moscow testifies to the fact that the Soviet research administrators, such as Gvishiani, were not only seriously interested in global modelling, but that they also sought to communicate the importance of this approach to the political elite: the American scientists were taken straight to the villa of the mayor of Moscow, where, in an informal environment, they briefed high-ranking Soviet officials, including Gvishiani and his protégé, the future head of global modelling at VNIISI, Viktor Gelovani.[22] Moreover it is clear that the Soviets were able to differentiate between the fiercely Malthusian implication of *The Limits to Growth* and global modelling as a new type of technique for generating policy-relevant knowledge. This dual approach was evident in the Russian translation of this report: the thesis of no-growth was censored, whereas its author, Dennis Meadows, was warmly welcomed to the Soviet Union. Indeed, Meadows visited the Soviet Union more than twenty times, lecturing on computer-based modelling in Moscow and a dozen other cities. Before the publication of *Limits,* Gvishiani initiated the translation of Forrester's *Industrial Dynamics* (1961), which was published in Russian under the title *The Foundations of Cybernetics of Firm* in 1971.[23] Indeed, Gvishiani also supported the translation of *The Limits to Growth*, which was done at the Institute of Scientific Information on the Social Sciences of the Soviet Union (INION), Moscow. However, the Russian translation of *Limits* was distributed only in limited circles within the Soviet Academy of Sciences and held in the tightly regulated special collection at the Lenin Library.[24] Although some entrepreneurial individuals secretly copied the INION's translation of *The Limits to Growth* and sold these copies for 300 USD on the black market, the wider Soviet public only had access to the ideological commentaries on this report.[25]

[INSERT FIGURE 5.1 HERE]

Figure 5.1: Seminar at the Laboratory of Viktor Gelovani, presented by Jay Forrester, at the All-Union Scientific Institute for Systems Research (VNIISI), Moscow; the 1970s. Courtesy of the Institute for Systems Analysis, Moscow.

In this way, in the Soviet Union, just like in the West, The Limits to Growth was received with both scepticism (it was described as the most criticized model ever) and fascination. In any case, the path-breaking role of *The Limits to Growth* in the opening up Soviet interest to a new understanding of the basic parameters necessary for scientific governance, cannot be denied. The long-term perspective and an understanding of complexity were beginning to be integrated into the Soviet governmentality: both retrospective accounts and published sources reveal the strong interest of Soviet scientists in developing the technique of global modelling, applying it to different policy areas and interacting with their Western colleagues (See Figure 5.1). For instance Mihajlo Mesarovic, a prominent US systems theorist and computer scientist of Serbian origin, the author of another global model also sponsored by the Club of Rome, presented his work at the House of Friendship in Moscow, the public forum from which many prominent Western scientists addressed Soviet audiences.[26] In the next section, I show how global modelling was developed at two international nodes of East–West interactions: IIASA and the UN. Then I return to the developments inside the Soviet Union to discuss the consequences of these international interactions within the authoritarian regime.

International Node 0.1: IIASA

IIASA played a fundamental role in the development of global modelling thanks to its unique institutional design and scientific agenda for developing cutting-edge policy sciences. The idea of an East–West institute was adopted by Lyndon Johnson's administration as part of their bridge-building policy and announced officially in October 1966.[27] Many different actors were behind this proposal: similar ideas for an international think-tank were articulated by econometricians who required access to data on the world economy. For instance, Wassily Leontief called for an East–West centre as early as the late 1950s. Also, the US president's economic advisor, Francis Bator, who contributed to the actual writing of Johnson's bridge-building speech, suggested the idea of an East–West centre for agriculture and management in the summer of 1966.[28] Concrete steps to organize an institute that would address the common problems were taken by former US presidential national security advisor George McBundy and Soviet Prime Minister Aleksei Kosygin. It took more than four years of negotiations among high-level policy makers, such as Gvishiani, McBundy, British government science advisor Solly Zuckerman and President of the US National Academy of Sciences Philip Handler, to agree on the institutional design, research agenda and location of the East–West institute.

In these negotiations the trajectories of the Club of Rome and the US–Soviet negotiators often intersected: for instance, Peccei not only facilitated the meeting of Gvishiani, Bundy and Zuckerman in 1968, but was involved, although not always directly, in the negotiations. This intertwining of the networks of the Club of Rome and the East–West institute turned out to be both an asset and a problem.[29] Purely coincidentally, the IIASA charter was signed several months after the publication of *The Limits to Growth* in 1972. The signatories worried that public opinion might confuse the IIASA and the Club of Rome, especially because some of the IIASA's founding members were fiercely critical of the Forrester/Meadows model.[30] One such was Zuckerman, who in his address to the UN conference on the Human Environment in Stockholm in 1972 argued that global problems should be faced "in a hopeful and scientific spirit and not in one of hysterical computerized gloom."[31] MIT scholar Carl Kaysen, who was McBundy's right hand man in the negotiations over the IIASA, was similarly sceptical about Meadows's model.[32]

In this context, it was not self-evident for IIASA to include global modelling in its research agenda. On the one hand, the newly born IIASA still had to earn its scientific reputation and, consequently, avoid risky projects. On the other hand, global modelling was a genuine innovation and therefore an opportunity to appear at the forefront of science. The dilemma of whether to model or not to model at IIASA was resolved by its first director, American mathematician and decision-scientist of Harvard, Howard Raiffa. IIASA, Raiffa proposed, would not develop any original models, but instead would become a clearing house for global modelling experiments undertaken in different countries.[33] Hence IIASA's research strategy of 1973 included methodological studies of "long-run global simulation" and a series of conferences on this topic.[34] Having hosted six symposia on global modelling from 1974, IIASA became the first platform for sustained international exchange in the area of global modelling.[35]

The IIASA's global modelling conferences played an important role in socialising scientists from East and West into a shared understanding of the possibilities, but also, importantly, the limitations of global modelling. First of all, global modelling was institutionalized as a "normal," albeit post-positivist science. In their internal discussions, as well as published papers, scientists acknowledged that many of the projections generated by global models could not be verified by empirical experiments. Furthermore, the modellers recognized that modelling results were often messy and inconclusive; many modellers, although not all of them, never attempted to hide the inconclusive character of their studies. In this way, it was neither accuracy nor proof, but uncertainty which loomed large behind global modelling.[36] Scientists, for example, agreed that precision was at best something to be aspired to, but that could hardly ever be reached: the data produced by computer models was subject to random errors. Another peculiar feature of global modelling was the discrepancy between the shortage of input data, which was often severely limited and imperfect, and the overflow of output data. Indeed, computers would churn out such volumes of alternative calculations that further software filters had to be designed to figure out which results made sense and which did not.[37]

Special social skills were needed to be able to navigate this complex world of global modelling. For instance, one interviewee, a Russian mathematician, emphasized that a particularly high "mathematical culture" was needed to use a global computer model properly. According to this informant, such a mathematical culture could not be learned from books, but could only be acquired from close and lengthy interaction in modelling teams.[38] It is doubtful that IIASA, where most scientists were visiting and the directors were appointed on temporary contracts, could ever become such a high-brow milieu of mathematical modelling, where sustained face-to-face contacts were paramount. However, IIASA could and did provide mathematicians from East and West with a unique place for meeting.

Discretion was another important quality that IIASA conferences could offer the emerging world community of computer modellers. Being an international, non-governmental organization, the IIASA could not easily be accused of being biased toward particular national or industrial interests. Both printed sources and oral interviews underscore the importance of IIASA's organizational culture of discretion, which enabled the modellers to discuss the most politically unorthodox versions of development. For example, in 1980 an IIASA global econometric modelling conference discussed the implications of Poland and Hungary joining the European Economic Community.[39] Discretion was highly important not only for political, but also for commercial reasons. Scientists were anxious about having their models in progress secretly copied, because then a modeller risked losing his or her potential income from commissions. However, complete discretion also posed a serious problem: without access to the model's architecture, an outsider could never tell if a particular model really worked, that is, if a model had an inner dynamic and if inputs did not straightforwardly determine outputs. The history of modelling shows that refusal to disclose the inner architecture of models ultimately jeopardized their authority.[40]

International Node 0.2: The UN

Whereas the IIASA offered a place for scientists to develop their global models in a discrete environment, where informal exchange of ideas and mutual scrutiny was made possible behind closed doors, the UN operated on different principles. Based on governmental membership, UN agencies could not offer the same level of discretion and informality (IIASA's members were not governments, but academic organizations). Nevertheless, global modelling pursued at UN agencies was significant, because the UN had a particularly important mandate to collect and share data from the West with the East. The importance of personal contacts and, to a more limited extent, face-to-face cooperation, is revealed in the models of the world economy, which were developed under the aegis of the UN.

It has to be recalled that the institutionalization of mathematical modelling in economics dates back to 1930, when the US-based Econometric Society was established by Ragnar Frisch. However, these early models were mainly theoretical exercises; econometricians began to fill their models with data only after the Second World War. As mentioned earlier, in 1961 the UN began promoting long-term economic planning, equipped with what were then new computer technologies. In 1965, the UN acquired its first mainframe computer and from about the same time began organizing a series of econometric conferences. To meet its needs for international data calculation, the UN established its International Computing Centre in 1971.[41]

The UN supported econometric research as part of its worldwide development program, the rationale for which was shaped in line with modernisation theory. According to modernization theory, Third World countries should imitate Western standards and economic structures. At a later stage the UN development agenda was widened to include environmental issues, the importance of which were indicated in *The Limits to Growth*. In 1973 the UN initiated a study of the interrelationships between growth, resources, pollution and abatement policies.[42] It was this coupling of the economy and environment that justified the inclusion of communist and capitalist regimes into a single modelling system: the geophysics of the Earth did not respect national boundaries and ideological divides.

In this context, the key Soviet organization to liaise with the UN world development planning program was the Central Institute for Mathematical Economics (TsEMI) at the Soviet Academy of Sciences in Moscow. Established in 1963 and directed by Nikolai Fedorenko (also a member of the Club of Rome), TsEMI enjoyed limited scientific autonomy in the Soviet empire of science and actively sought to join the most prominent international activities.[43] Hence in 1965, Fedorenko attended the first econometrics congress in Rome on the invitation of Wassily Leontief,[44] and TsEMI was also invited to the Copenhagen conference on long-term economic planning that was organized by the UN Economic Commission for Europe in 1966.[45] During the 1960s, TsEMI corresponded and exchanged publications with such pioneering modellers of the long-term as Ragnar Frisch, Jan Tinbergen, and Richard Stone.[46]

Yet the key actor in my narrative is Wassily Leontief, a tireless mediator between Western and Soviet econometricians, as well as a recipient of the Nobel Prize for his method of calculating inter-branch balance in 1973. Leontief was born into a well-off family of Russian industrialists and academics in 1909 and grew up in Saint Petersburg, where he witnessed the Russian revolution unfold.[47] Leontief left Russia in 1925 and returned for the first time in 1959. At the beginning of his exile, he worked at Kiel University in Germany, one of the first institutions to study the world economy in Europe. In the 1930s, Leontief was invited to advise the Chinese government on the development of railway infrastructure. It was during his long trip to China and back that he first encountered the Third World. In 1931, he was invited to join the National Bureau of Economic Research and soon thereafter became a professor at Harvard. Leontief first presented his theory of systems dynamics to the military in Washington, DC; in 1948–1949 his empirical input-output studies were funded by both the Rockefeller and Ford Foundations under the Harvard Economic Research Project.[48] Leontief's mathematical skills, his life experience and proximity to government agencies made him a rather unusual non-academic economist, who was keenly interested in the development of large scale and long-term models.

It was during de-Stalinizaton that Leontief's work entered the Soviet space to later become a standard reference in Soviet global thinking.[49] Thanks to the efforts of the mathematician Vasilii Nemchinov, the Soviet Union legitimized mathematical methods in economics in the mid-1950s. Then Leontief's pupil, Polish economist Oskar Lange, inspired the Soviets to use input-output methods for planning purposes. In 1959, Leontief was officially invited to Moscow, a visit which he described in his memoir as unsatisfactory, having discovered insufficient competence amongst the Soviet economists. However, following this visit Leontief established and chaired the US-Soviet Statistics Bureau in Cambridge, Massachusetts, where many young Soviet administrators were subsequently trained. In this context, it is not surprising that it was Leontief, so well personally integrated in East–West networks, who was commissioned to direct the first study of the world economy for the UN.

At the requested of the UN Centre for Development Planning, Forecasting and Policies, Leontief created the first world trade balance model, the results of which were reported in The Future of the World Economy (1976). One of his co-authors was Stanislav Men'shikov, a Russian economist who would later feed the data gathered for Leontief's report to the information-starved economists in Moscow. The data, typically, did not flow in the opposite direction: Leontief's report did not list any Soviet sources.

Outlining scenarios for world development for the next twenty-five years, The Future of the World Economy treaded carefully in the terrain of Cold War political divisions. First, the rationale for making such a model was derived from environmental concerns, deemed to be globally relevant and universal irrespective of political ideology. Although the logic of the model was primarily economic (investment and trade flows), it was precisely the environmental effects of economic growth, argued Leontief, which required the introduction of a long-term perspective into the study of development.50 Second, the political implications of Leontief's analysis were carefully managed. One finding was that without foreign investment, it was impossible to narrow the income gap between developed and developing countries by the year 2000. But such a statement would have placed a direct responsibility on Western governments and was therefore understood as politically controversial at the UN. Accordingly, this finding was left implicit in the report.[51] Third, Leontief depoliticized the very conceptual structure of the world model in many ways. For instance, the model elaborated on possible changes in internal economic structures in developing countries, but no change at all was modelled for the communist regions. Then, world regions were defined according to their economic-administrative system and geographical features. Hence the Soviet Union and Eastern Europe were called "developed centrally planned regions"; meanwhile Western Europe was split into high and medium income regions.[52] As a result, Leontief's model, on the one hand, erased the communist and capitalist divide from the future of the world economy. Yet, on the other hand, Leontief's model conserved the political status quo by avoiding the modelling of changes within the communist system.

A Future Less than Bright? Global Models of Soviet Decline

Both Meadows's and Leontief's models grew out of attempts to clarify the possibilities of economic development and its consequences for the environment from a long-term perspective. Although the computer technologies that were used were new, the concern with the environment was not. In Soviet Russia, a particularly important role was played by the Russian intellectual tradition which was conducive to the emerging global environmentalist thinking. Indeed, the Soviet intellectual interest in the modelling of global processes predated both Meadows's and Leontief's studies because it stemmed from pre-war thinking, in particular from Vladimir Vernadskii's idea of the noosphere, which was formulated in the 1930s.53 From the 1960s Vernadskii's thought was promoted by the prominent Soviet biologist Nikolai Timofeev-Resovskii and the prominent mathematician and research director of the Computer Centre, Nikita Moiseev.[54]

As in Western scholarship, Soviet efforts in global modelling oscillated between the economic and geophysical poles. Under Moiseev, the Computer Centre became the heart of geophysical modelling with a particular focus on climate and ecological systems. The focus on interaction between the economy and the environment, as well as the interest in systemic breakdown, was inspired by The Limits to Growth, which was discussed at Moiseev's seminar at the Computer Centre.[55] Indeed, Moiseev was first introduced to the global problematique of the Club of Rome by the prominent Canadian economist of Russian origin Paul Medow, who lectured on Forrester's model at the Centre in the early 1970s. The networks intertwined: Medow, in turn, invited Moiseev to take part in a meeting organised by the Club of Rome and the RAND Corporation.[56]

Just like his Western colleagues, Moiseev found Forrester's and Meadows's World models mathematically imperfect and limited in their conceptual structure. According to Moiseev, the World models were not good as policy tools for decision-making; indeed, Moiseev was generally sceptical about the use of modelling in economic planning. This scepticism was rooted in his hands-on experience of defining statistical variables for social and economic indicators at the State Planning Committee (Gosplan). Moiseev did, however, compromise, contending that global economic models could be created in principle, but only on the basis of "proper" geophysical modelling. For Moiseev, if the natural processes were not properly understood and represented, it was pointless to model the economy, dependent on natural resources.[57]

A different view was held at VNIISI, which listed global modelling as one of its research priorities. Established under the patronage of Gvishiani, who personally promoted global modelling in the Soviet Union and at IIASA, VNIISI was a very important institute, which, however, so far has been overlooked by historians of Soviet science.[58] VNIISI's global modelling program was directed by another Georgian, Gelovani, who kept direct and close connections with Meadows. If the Computer Centre made a major contribution to the field of geophysical modelling, VNIISI innovated in global economic modelling in the Soviet context.[59]

Both the Computer Centre and VNIISI were closely connected with IIASA and the UN.60 Gvishiani was the director of VNIISI from 1976 to 1992 and vice director of IIASA from 1972 to 1987. Moiseev was involved with water projects at IIASA and was also behind the Computer Centre's participation in the UNESCO program Man and Biosphere, which launched an ambitious international study of the intertwining of man-made and natural systems at the planetary level. Although Moiseev held different views from Gvishiani, their networks closely intertwined. For example, the Balaton Group that modelled the pollution of Lake Balaton in Hungary at IIASA included junior scientists from the Computer Centre and was established jointly by Meadows and Gelovani in 1982.[61]

Importantly, global modelling also entailed horizontal, transnational relations between strong researcher milieus. The first computer-based world model, simulating the interaction between the ocean and atmosphere, was developed by American scientists Syukuro Manabe and Kirk Bryan in 1972. Somewhat later the Soviets also began developing their own geophysical global models. From 1977, the Computer Centre launched a research program to build a world ocean-atmosphere model suitable for environmental analysis; this model was completed in 1982.[62] It should be noted that the development of world models was more creative bricolage than creation ex nihilo. For example, in an interview, a Russian mathematician involved in the development of the first global models stressed that his team did not compete for originality; on the contrary, they found it acceptable to borrow already existing models, created by Western scientists. These Western models were adjusted to both local research goals and computer equipment, namely, the Centre's BESM-6.[63] The Computer Centre borrowed a global circulation model, created by Yale Mintz and Akio Arakawa at the University of California Los Angeles, and then improved by Lawrence Gates, first at RAND (1971) and later at Oregon University (1978).[64] Well anchored in Soviet networks, Gates did not mind giving his model to the Soviets and even proposed sending two American scientists to Moscow to help adjust the model to the Russian computer BESM-6.[65] Indeed, not only models, but also data was shared transnationally: the Computer Centre received atmospheric data from the Norwegian Meteorological Centre.[66]

The conceptual rationale of Soviet global models addressed concerns similar to those of The Limits to Growth, but also extended them further in reconceptualising the role of humanity on Earth. Thus, Moiseev envisioned an integrated model of the biosphere, putting the natural, socio-economic and cognitive environment into one model in an attempt to study the large scale effects of anthropogenic activities.[67] This model simulated interconnections among global climate, ecology and economic systems, aiming to identify the conditions under which environmental change would set boundaries for economic development.[68] Yet the economy was of secondary interest for Moiseev's group: this model, involving land, ocean and atmosphere blocks, was first used to simulate CO_2 emissions and climate change in the early 1980s. Another aspect illustrating the difference and possibly some rift between Moiseev's and Gelovani's teams is that the Computer Centre's global model was created independently of IIASA: the Computer Centre's scientists did not participate in IIASA's global modelling conferences.[69] In the late 1970s, Moiseev's group directly cooperated with American and French modelling teams, and their cooperation with IIASA would intensify only in the 1980s.[70]

It soon became clear that although global models were meant to study apolitical, geophysical processes, they led to the formulation of innovative political and policy ideas. Here the most prominent study done on the Computer Centre's model was a simulation of the long-term environmental consequences of nuclear war, conducted in cooperation with Western scientists within the framework of the Scientific Committee on Problems of the Environment (SCOPE) of the International Council of Science Unions (ICSU). The result was a Soviet-American report about nuclear winter, released in the autumn of 1983.[71] The models simulated the effect of nuclear explosions on world climate, ecological systems and population. The American team first traced the consequences of nuclear war over the period of one month, whereas Moiseev's team traced the consequences over one year, discovering that nuclear war would cause darkening of the atmosphere, significant cooling and extinction of the majority of plants and animals in the Northern, and parts of the Southern hemisphere. At a later stage, scientists examined even longer term consequences of nuclear war, tracing changes to the global environmental system for thirty years. These findings showed that even a limited nuclear war would cause irreversible environmental change and affect the whole of humanity.[72] The nuclear winter study was used by disarmament activists, deeply influenced public opinion in both West and East, and contributed to incremental change in nuclear strategy thinking.[73]

The nuclear winter simulation introduced a long-term element which previously had not been considered in nuclear strategies concerned with short-term damage calculations. Unlike The Limits to Growth, the nuclear winter study was made public in the Soviet Union. The modelling exercise transformed the understanding of nuclear war from a potential conflict between the US and the Soviet Union into a global disaster, which would affect both North and South. Just like Leontief's Future of the World Economy, albeit for different reasons, the nuclear winter study made redundant the idea of a systemic divide between capitalism and communism by showing that the ash of both systems would be indistinguishable.[74] The Soviet Union, in other words, could not win the nuclear war in any meaningful sense.

The impact of global modelling efforts at VNIISI was quite different but no less significant. Global modelling was a prominent part of VNIISI's research agenda from its establishment in June 1976: the first report of annual activities included the development of a conceptual framework for global modelling.[75] VNIISI was exceptionally well positioned to tap into international science because it was created to be the Soviet counterpart of IIASA. Claiming that the Eastern bloc lagged behind the West in global modelling, VNIISI's purpose was to "catch up" with the West by developing interdisciplinary research on large-scale, complex and global problems.[76] Thanks to Gvishiani, VNIISI had a direct link to the heart of Soviet power. For instance, in 1977 a high-level meeting of global modellers, including members of the Club of Rome, was organised in Moscow, where five members of Politburo, the de-facto highest decision-making body in the Soviet government, attended.[77] If global modellers at the Computer Centre first and foremost developed their models as tools for gaining new scientific knowledge about geophysical systems, VNIISI sought to generate policy-relevant knowledge.

In the context of Soviet academia, VNIISI was an important, large and well-funded organization. The global modelling program at VNIISI was co-chaired Gvishiani and Gelovani.[78] This global modelling group stemmed from a GKNT team for operations research that was involved in creating complex models of world development.[79] This team also included a prominent scientist, Sergei Dubovskii, with experience of modelling from the highly esteemed Institute for Control Sciences. These and other scholars who later shaped the core of VNIISI were closely involved in the formation of IIASA's research agenda from 1972.[80] Unlike IIASA, which never hosted more than 100 scholars at a time, and in the true spirit of a Soviet organization, VNIISI employed more than 300 staff and grew to almost 700 in the late 1980s.[81] The Institute was well provided with a large building and its technical equipment was more than adequate: VNIISI modellers used PDP-11/70, an American computer.[82]

The principal task of VNIISI was to forecast the development of countries and regions for a twenty to thirty year period.[83] The idea to forecast social and economic development for the year 2000 stemmed from the work of the US Commission for the Year 2000.[84] Such forecasts were made in the Soviet Union from the 1960s, although most of them were kept secret. A glimpse at the archives and memoirs reveals a much more complex and diverse landscape of Soviet scientific expertise than previously thought: at VNIISI, scientists looked farther ahead to test the impact of globally significant changes on the Soviet Union. For instance, the first global dynamics model developed at VNIISI forecasted the impact of armament on the Chinese economy. The model showed that increased investment in defence would devastate the Chinese economy; it was therefore concluded that China was not likely to consider military expansion. Accordingly, the Soviet government did not have to invest to counteract Chinese military growth. Ironically, this model used the existing intelligence data on China, but could not model fine-grained impacts on the Soviet Union, because Gosplan refused to give them Soviet data.[85]

Nevertheless, other studies explored the development of the Soviet economy as part of global dynamics. If in 1981 VNIISI had a model which consisted of three blocks, representing the US, Japan and China, in 1983 this model was expanded to include the communist bloc. Unlike Leontief's model for the UN, which did not divide the world according to nations or political regimes, VNIISI's model divided the world along political allegiances into nine blocks: the Soviet Union, the Eastern European bloc, the European community, the US, China (the power of which was of growing concern to the communist leaders), Japan, "other capitalist countries," OPEC countries, and developing countries. Sector-wise, this model included demography, trade, energy resources, the environment and climate.

However, just as before, Gosplan was not forthcoming with the Soviet data; only highly aggregated statistics were available. What did VNIISI modellers do? They turned to their personal, transnational contacts to solve this data gap. This was the colleague of Leontief mentioned earlier, the Russian economist Stanislav Men'shikov, the vice-director and then director of the UN Department of Prognosis, Planning and Development, 1974–1980.

Men'shikov boasted good personal relations with some of the most prominent US intellectuals, such as the economist John Kenneth Galbraith; the two met at a lunch with David Rockefeller at the US Embassy in Moscow in the mid-1960s. In 1988, Men'shikov and Galbraith co-authored the book Socialism, Capitalism and Co-existence.[86] Indeed, the cooperation between VNIISI and the UN was built on strikingly intertwined socio-technical networks, which joined machines, organisations and individuals: Men'shikov worked with Leontief on the UN world economy model. Furthermore, Leontief's world economy model was computed on a PDP-10 at the Feldberg Computer Centre, the same type of machine as VNIISI had.[87] IIASA provided the data about global markets.[88] Scholars recalled that they could easily obtain CIA reports on the Soviet economy, industry and society, but not the data from the State Committee for Statistics (Goskomstat).[89] The result was a gargantuan modelling system joining 47 models, 4,700 averaged points and 5,000 variables, and based on quantification of 370,000 empirical observations. On this basis, the world system and Soviet development was projected for the next twenty years.[90]

It should be clear by now just how painstaking of a process it was for Soviet scientists to make such long-term projections. It is quite significant that Soviet scientists used long-term projections to reveal the current problems that the Soviet Union faced, but which could not be explicitly identified for ideological reasons. Long-term projections into the future, meanwhile, constituted an important rhetorical device to show the roots of the problems. Thus VNIISI scientists reported to Prime Minister Kosygin and, later, Nikolai Tikhonov, in 1979, 1982 and 1984, each time demonstrating that the growth of the Soviet economy would sharply decline in the future unless the Soviet government sharply upped investment in research and development.[91]

This was not a trivial warning. Indeed, very few communist scientists dared to model the slow-down or, worse, non-growth of Soviet economy. For instance, TsEMI's director retrospectively wrote that he "just could not accept" even as a hypothesis the zero-growth option proposed by Meadows's report.[92] In turn, the hypothesis of zero growth was censored out of the Russian translation of The Limits to Growth.[93] Yet there was some, albeit limited space for Soviet scientists to offer negative feedback to the government. A well-known example is that of the Russian economist Gregory Khanin, who repeatedly wrote letters to the Central Committee reporting his own estimates of the future Soviet economy, which were much lower than the official figures.[94] Whereas Khanin was tolerated and, probably, ignored, other scientists were less fortunate: for instance, the East German scientist W. Harich calculated a version of non-growth communism, for which he was seriously repressed.[95] Another example of a reaction to economic forecasts showing the decline of Soviet economic power involved IIASA's project on modelling economic growth, directed by the German economist Wilhelm Krelle. Dissatisfied with Krelle's results, several Russian scholars complained that it was "a big mistake" to show that the impact of the Soviet Union on world economic development was minor. They wrote that if Krelle used the official forecast for the year 2000, the global role of Soviet trade would have been much more significant.[96] Indeed, according to my interlocutors, who were involved in these discussions, VNIISI scientists did fear repression and this is why the scenario of the collapse of the Soviet Union was not tested at all.[97]

Furthermore, the VNIISI model revealed deep divisions among the scientists involved, who disagreed about the actual purpose of long-term analysis. One scientist told me that several VNIISI economists involved in the development of this model simply refused to believe that the model was expected to produce unanticipated results. Well drilled in the communist planning system, these economists assumed that the modelling exercise was merely a ritual, an attempt to create “a mechanic proof” for plan targets, specified in the Party directives. Others were anxious that their results might be understood as a criticism of the standard of Soviet life, so demographers simply refused to take into account the influence of the quality of life on birth rates.[98] Finally, it is very likely that the curve pointing out the decline of Soviet growth from 4.5 percent in 1980 to 2.1 percent in 2000 was also a cautiously selected one: this curve was diplomatically accompanied by another curve, which showed that US growth would slow down even more.

Nevertheless, it is clear that some Soviet modellers regarded their task as a serious and genuine contribution to policy processes by “speaking truth to power”, to use Aaron Wildawsky’s terms, and not just as a mere ritual. This is why they sought to make their studies public. In 1984, this VNIISI modelling exercise was described in a report On the Threshold of the Millennium: The Global Problems and Development Processes in the USSR; the following year, some of the results were published in VNIISI proceedings. However, the Main Directorate for Literary and Publishing Affais (Glavlit), which was also the central censorship organ, requested that most of the information concerning the Soviet Union was removed in order to be suitable for a wide audience.[99] Whereas Soviet censorship found it acceptable to publish studies on the complete extinction of Soviet citizens during a nuclear winter, it would not release a forecast of the slowing down of Soviet economic growth from the optimistic five percent to what was considered a meagre two percent.

These examples show that although there were pretty clear boundaries to the criticism of the Soviet regime, some Soviet global modellers persistently tried to push them. Soviet scientists used a sophisticated tool, computer-based global modelling, as a vehicle to criticize the Soviet economy by showing its imminent failure to the Politburo. In this way, the long-term projections, I suggest, enabled new kinds of criticism before the new policy of openness, or glasnost. launched by Mikhail Gorbachev in 1987.

For the Soviets, the struggle for the long-term was inevitably a struggle for access to models, data and computers. It is difficult to overestimate the role that the scientific methodology of global modelling played in international cooperation. No global model could run without empirical data. No national model of natural or economic systems could be realistic if global processes were not plugged into it. Nothing clashed harder with the Soviet bureaucracy, pervaded with secrecy and compartmentalisation, than the idea of unrestricted international circulation of data. Here, the modelling of geophysical processes, particularly the studies of environmental change, enabled Soviet scientists to experiment with formulating alternative visions of the Soviet future. If, in the 1960s–1980s, many of the Soviet demographic statistics were not available, as Gosplan would not disclose the population mortality rates from the 1930s-1940s,100 the data on the atmosphere and the ocean could be circulated more easily, which explains the Computer Centre's focus on geophysical global models. But then, models and data were co-produced: for instance, the global models required new kinds of data drawn from specially conducted experiments, because, for example, nitrogen reactions were different in Siberia and Latin America. The modelling software itself was not easy to replicate; without direct face-to-face communication, wrote Moiseev, sophisticated mathematical models could never become "real."[101]

Conclusion

For the Soviet government global modelling was both an instrument for policy making and a symbol, part of the struggle for super power status. Soviet scientists aspired to use big computers to project big data over the long-term and long-range world future and do this just as well as the US scientists. Brimming with political prestige, global modelling served as an important source of authority for Soviet scientists, who wished to innovate not only in science, but also in policy-making. And they were innovative: global modelling posed deep challenges to the secrecy and compartmentalization of Soviet scientific expertise. This chapter shows that global modelling demanded international, face-to-face cooperation to co-produce both the models and data. As a result, the Soviet government eventually began to release control over small communities of modellers, which remained close to, albeit at arm's length from, central power. Second, global models made visible through graphs, maps and statistical curves different, unexpected and negative consequences of long-term developments. In some areas, such as the natural environment or global trends, this long-term future was actively portrayed as global and politically neutral. It is highly significant that Soviet scientists used references to such a neutralized global future to criticize contemporary Soviet realities.

Global models were constitutive to the emerging understanding of the global future as a truly interdependent affair. The discourse of interdependence became a new diplomatic language of non-zero-sum games. For instance, the GKNT's head of foreign relations would assure his Japanese visitors that the Soviets understood the world "as a system of partners," where "when the system as a whole wins, each partner wins."[102] Deeds, unsurprisingly, did not always follow from the words: Soviet statistical agencies refused to provide the data either to Soviet or Western scientists.[103] In spite of these difficulties, Soviet global models were, to use Brian Wynne's words, "more than its final results." As showed in this chapter, global modelling transformed from being a mere channel for feeding data to the policy maker's office into a large enterprise of "policy argumentation."[104]

Furthermore, global modelling drove a deep epistemological transformation of the computer-based Soviet governmentality. The governmental role of computers was not limited to what Donald MacKenzie called the mechanization of proof.[105] Rather, Soviet discussions about the methodology of global computer-based modelling articulated and disseminated a non-determinist worldview, in which a great many areas of nature and human activity were understood as probabilistic or even purely uncertain. The message of the global models to the communist government was that total control was impossible in the long-term. In this way, instead of producing certainty, global computer models time and again reminded officials of the boundaries of the human knowledge and scientific methods of control.[106]

Global modelling, in this way, permitted a different way of relating to the future of communist society. Although Soviet scientists cautiously avoided directly challenging the ideological dogma of the superiority of the communist system, the uniqueness of the communist system was simply made redundant. By the early 1980s, the scientists framed global problems as an issue of a metabolic relation between the man and biosphere, something which was beyond the Cold War struggle for global hegemony, became legitimate and central in the Soviet Union.[107] This globalist environmental discourse slowly but steadily accumulated power as the key framework for economic development strategies and, in doing so, as Dmitrii Efremenko notes, the global environmental framework was parallel to and only rarely intersected with Marxist-Leninist political economy.[108] The focus on long-term global and environmental processes enabled Soviet scholars and policy makers to point out that the Soviet economy and society also had serious problems, which were of universal and global character and which could not be internally resolved.

Moiseev was especially acute on this, claiming as early as the 1970s that there was a need to focus on new problems in order to prepare for the new world of advancing computer technologies.[109] We should not dismiss this call as trivial rhetoric: it was, indeed, a smart way of suggesting that the Soviet system was stuck in solving its old problems. To suggest changing the whole system would be too revolutionary, even for such an independentminded Soviet scholar as Moiseev. Instead, he suggested turning to new problems, ones of global and long-term character. The attempt to solve these new problems could and did transform the Soviet system.

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11 J. D. Bernal, The Social Function of Science (London: Lowe & Brydone Printers, 1939/1946), 409.

12 For the US version of technological modernisation as both solution and problem, see Michael Latham, The Right Kind of Revolution: Modernization, Development and U.S. Foreign Policy from the Cold War to the Present (Ithaca, NY: Cornell University Press, 2011).

13 Bruce Allyn, “Fact, Value, and Science,” in Loren Graham, ed., Science and the Soviet Social Order (Cambridge, MA: Harvard University Press, 1990), 238. For more on Bernal, see Andrew Jamison, “Technology’s Theorists: Conceptions of Innovation in Relation to Science and Technology Policy,” Technology and Culture 30, no. 3 (1989): 505–533.

14 I base this statement on the use of the term “global” in the Gosplan documents, kept at the Russian State Economic Archives (RGAE).

15 Vadim Zagladin and Ivan Frolov, Global’nye problem sovremennosti: nauchnyi i sotsial’nyi aspekty (Moscow: Mezhdunarodnye otnosheniia, 1981).

16 Ibid, 25, 33.

17 For more, see Vieille Blanchard, this volume.

18 Paul Edwards, “The World in a Machine: Origins and Impacts of Early Computerized Global Systems Models,” in Agathe C. Hughes and Thomas P. Hughes, eds., Systems, Experts and Computers: The Systems Approach in Management and Engineering, World War II and After (Cambridge, MA: MIT Press, 2010).

19 Immediately criticised as flawed and imperfect, this experiment of projecting world development up to the year 2050 stirred huge interest from the scientific community: in just four years a further nine major world development models were created. Gvishiani, “Methodological Problems,” 22–27.

20 Dzhermen Gvishiani, Mosty v budushchee (Moscow: URSS, 2004), 77.

21 For instance, Forrester’s and Meadows’ model was discussed in a symposium on trends in mathematical modelling, organized by the Italian National Research Council and UNESCO in December 1971. In addition to Dennis Meadows, participants included prominent Russian scientists, such as the mathematician Nikita Moiseev and specialist in economic modelling Kirill Bagrinovskii, as well as the leading American futurologists Olaf Helmer and Alvin Toffler. Nigel Hawkes, ed., International Seminar on Trends in Mathematical Modelling, Venice, 13–18 December 1971 (Berlin: Springer Verlag, 1973).

22 Interview 35, 4 March 2014; Donella Meadows, John Richardson, and Gerhart Bruckman, Groping in the Dark: The First Decade of Global Modelling (Chichester, UK: John Wiley and Sons, 1982); Gvishiani, Mosty.

23 Jay Forrester, “System Dynamics and the Lesson of 35 Years,” in Kenyon De Greene, ed., A Systems-Based Approach to Policymaking (Springer, 1993), 199–240.

24 V. A. Gelovani, V. B. Britkov, and S. V. Dubovskii, SSSR i Rossiya v globalnoy sisteme (1985–20130): rezultaty globalnogo modelirovaniia (Moscow: Librokom, 2009), 48; Efremenko, Ekologo-politicheskie, 104; Interview 28, 15 April 2013. All informants signed an agreement to be interviewed and they are fully anonymized in order to protect their identities.

25 Interview 22, 13 December 2012.

26 Sergei Dubovskii, “Global’noe modelirovanie: voprosy teorii i praktiki,” Vek globalizatsii 2 (2010): 57; Sergei Dubovskii and O. A. Eismont, “Long-Range Modelling of the USSR Economy,” in Wilhelm Krelle, ed., The Future of the World Economy (Berlin: Springer Verlag, 1989).

27 For more, see Leena Riska-Campbell, Bridging East and West: The Establishment of the International Institute for Applied Systems Analysis in the United States Foreign Policy of Bridge Building, 1964–1972 (Helsinki: Finnish Society on Science and Letters, 2011); and Thomas Schwartz, "Moving beyond the Cold War: The Johnson Administration, Bridge-Building, and Détente," in Francis Gavin and Mark Atwood Lawrence, eds., Beyond the Cold War: Lyndon Johnson and the New Global Challenges of the 1960s (Oxford and New York: Oxford University Press, 2014); see also Eglė Rindzevičiūtė, Riders on the Storm: How Cold War Scientists Co-Operated to Create Global Governance, in progress.

28 Schwartz, "Moving beyond the Cold War"; Gvishiani, Mosty, 87.

29 Gvishiani, Mosty, 141.

30 H.S.D. Cole, C. Freeman, M. Jahoda, and K. Pavitt, eds., Thinking about the Future: A Critique of the Limits to Growth (Sussex: Sussex University Press, 1973).

31 Barbara Ward et al, Science, Technology and Management: Who Speaks for Earth? (New York: Norton, 1973).

32 Carl Kaysen, "Computer that Printed Out W*O*L*F," Foreign Affairs 50 (July 1972): 660-668.

33 Howard Raiffa, Analytical Roots of a Decision Scientist: A Memoir (28 June 2005), an unpublished manuscript, IIASA archives, Laxenburg; Meadows, Richardson, and Bruckman, Groping in the Dark.

34 The International Institute of Applied Systems Analysis: Background Information, Provisional Research Strategy. Preliminary Version for Restricted Circulation (April 1973), IIASA Archives, Laxenburg, p.30.

35 IIASA global modelling conferences scrutinized the Mesarovic-Pestel model (1974), the Latin American labour model Bariloche (1974), the Dutch model of international relations in agriculture (MOIRA, 1975), the British Systems Analysis Research Unit model (SARU), which was developed by the Environment Agency (1976) and hence the only one funded by governmental body. Its version SARUM 76 was used by OECD Interfutures scenarios. Other models discussed at IIASA included the MRI (Polish national model) (1976), as well as the UN world model and the Futures of

Global Interdependence model (FUGI, 1977) (Meadows, Richardson, and Bruckman, Groping in the Dark, 2–4).

36 A. G. Ivakhnenko and V. G. Lapa, Cybernetics and Forecasting Techniques (New York: Elseviere, 1967); compare with Reuben Hersh, "Mathematics Has a Front and a Back," Synthese 88, no. 2 (1991): 127–133. See also an internal debate in Modelirovanie protsessov global'nogo razvitiia: sbornik trudov VNIISI, vol.8, Moscow, 1979.

37 The inability of global models to produce conclusive results led to redefinition of the purpose of modelling, which shifted from policy prescription to less formal insight. For instance, in 1979 at IIASA, Olaf Helmer created Global Economic Model (GEM), which did not "solve the problems directly," but to lead to "a better intuitive understanding of the problem structure." Olaf Helmer and L. Blencke, GEM: An Interactive Simulation Model of the Global Economy. RR-79–4 (Laxenburg: IIASA, 1979), 2.

38 Interview 31, 10 April 2013.

39 Moiseev to Gvishiani (1980), Archives of the Russian Academy of Sciences (ARAN), f.1918, op.1, d.463, l.4.

40 See Wynne, Models, 5; Bill Keepin and Brian Wynne, "Technical Analysis of IIASA Energy Scenarios," Nature 319 (20 December 1984): 691–695; Rindzevičiūtė, Riders on the Storm.

41 Information from http://unstats.un.org.

42 Wassily Leontief, A. Carter, and P. Petri, The Future of the World Economy: A United Nations Study (Oxford: Oxford University Press, 1977):1.

43 Jakob Mosak to Fedorenko (5 February 1965), ARAN, f.1959, op.1, d.92, l.19–20.

44 Fedorenko to Jakob Mosak, UN HQ Bureau of General Economic Research and Policies (this document is not dated, but it is filed in the folder for 1965), ARAN, f.1959, op.1, d.92, l.18; Fedorenko to Leontief (no date, the folder is dated 1965), ARAN, f.1959, op.1, d.92, l.60.

45 Gvishiani to Fedorenko (17 February 1966), ARAN, f.1959, op.1, d.129, l.15.

46 ARAN, f.1959, op.1, d.129.

47 Leontief's father was a professor who organised strikes in his grandfathers' factories. Bernard Rosier, ed., Wassily Leontief: textes et itinéraire (Paris: Éditions la découverte, 1986), 78–80.

48 Wassily Leontief, "The Decline and Rise of Soviet Economic Science," Foreign Affairs (January 1960): 261–272; Rosier, Wassily Leontief, 80, 90–92; David Engerman, Know Your Enemy: The Rise and Fall of America's Soviet Experts (Oxford: Oxford University Press, 2009): 97.

49 The Soviet philosophers appreciated Leontief's world model as "more realistic" than the models sponsored by the Club of Rome. Zagladin and Frolov, Global'nye problem sovremennosti, 11, 182, 189.

50 Leontief's study involved demographic, economic and environmental spheres with bench-mark years of 1980, 1990 and 2000. The world was divided into fifteen regions, each region comprising forty-five sectors of activities. The regions were linked via imports and exports of forty classes of goods and monetary transfers.

51 Leontief, Carter, and Petri, The Future, 1–3.

52 Ibid., 2, 34–35.

53 Nikita Moiseev, Algoritmy razvitiia (Moscow: Nauka, 1987), 5.

54 Timofeev-Resovski was the pioneering population geneticist. For more, see V. V. Babkov and E. S. Sakanian, Nikolai Timofeev-Resovskii (Moscow: Pamiatniki istoricheskoi mysli, 2002); Y. G. Rokityanskij, "N. V. Timofeef Resovski in Germany, July 1925–September 1945," Journal of Bioscience 30, no. 5 (2005): 573–580; on Vernadskii, see Jonathan Oldfield and Denis Shaw, "V. I. Vernadskii and the Development of Biogeochemical Understandings of the Biosphere, c.1880s–1968," The British Journal for the History of Science 46 (2013): 287–310.

55 Interview 34, 5 April 2013.

56 A. A. Petrov, Nikita Nikolaevich Moiseev: sud'ba strany v sudbe uchenogo (Moscow: Ekologiia i zhizn, 2011), 56.

57 Moiseev was sceptical about econometrics in general and even more so about Soviet econometrics, yet for him economic modelling was a lesser evil. Moiseev wrote that in order to succeed Soviet economic forecasting had to be based on "strictly scientific modelling systems" and

not "unreliable expert surveys." Nikita Moiseev, Prosteishie matematicheskie modeli ekonomicheskogo prognozirovaniia (Moscow: Znanie, 1975), 62; Moiseev to Gvishiani (1980), ARAN, f.1918, op.1, d.463, l.16.

58 For instance, Gvishiani published regularly articles promoting systems analysis and global modelling. See Dzhermen Gvishiani, "Sistemnyi podkhod k issledovaniiu global'nykh problem." In Nauka i chelovechestvo, 237–249. Moscow: Znanie, 1983; Dzhermen Gvishiani, "The Search for a Global Strategy." Unesco Courier (November 1979): 25–26.

59 Curiously, even at VNIISI, global modelling was split into two directions, the environmental and economical, and these two groups worked in parallel and did not directly collaborate (Interview 29, 15 April 2013).

60 Other milieus where Soviet global models of various kinds were developed included econometric modelling at the Institute of World Economy and International Relations (IMEMO), the Main Geophysical Laboratory in Leningrad, under Gurii Marchuk in the Novosibirsk branch of the Soviet Academy of Sciences, even at the Moscow State University (Dubovskii, "Global'noe," 55). It was Stanislav Men'shikov, the vice director of IMEMO who conducted econometric research as early as 1968 at IMEMO and later in Novosibirsk (Interview 34, 5 April 2013).

61 In 1987, Gelovani was also appointed as the head of the Soviet branch of the World Laboratory. The World Laboratory was an interesting Cold War effort: established in 1986, it was an NGO initiated by Dirac, Kapitsa and Zichichi. It was recognised by the UN, dedicated to facilitate East-West and North-South scientific exchange. S. Emel'ianov, ed., 30 let institute sistemnogo analiza Rossiiskoi akademii nauk: istoriia sozdaniia i razvitiia Institutea sistemnogo analiza, 1976–2006 gg (Moscow: URSS, 2006):129.

62 Otchet (1982), ARAN, f.1918, op.1, d.492, l.4.

63 Interview 34, 5 April 2013.

64 Lawrence Gates developed a model called OSU AGCM, which was detailed, but also faster and, unlike other American models, did not require that much computer memory (only 100Kb), which was very important for Soviet scientists who worked on the slow BESM-6. Otchet (1978), ARAN, f.1918, op.1, d.421, l.88.

65 ARAN, f.1918, op.1, d.421, l.89.

66 Interview 31, 10 April 2013.

67 For an early publication discussing human impact on environmental change, see William Thomas, Man's Role in Changing the Face of the Earth (Chicago: University of Chicago Press, 1956).

68 Interview 33, 14 February 2014.

69 Ibid.

70 Moiseev kept close connections with French scholars: taught French by his grandmother, he was less comfortable with English and there were many Russian exile scientists in Paris who were keen to welcome him. Petrov, Nikita Nikolaevich Moiseev, 50.

71 Lawrence Badash, A Nuclear Winter's Tale: Science and Politics in the 1980s (Cambridge, MA: MIT Press, 2009); Rindzevičiūtė, Riders on the Storm.

72 Yurii Svirezhev, Ecological and Demographic Consequences of Nuclear War (Moscow: Computer Centre of the USSR Academy of Sciences, 1985), 205.

73 Matthew Evangelista, Unarmed Forces: The Transnational Movement to End the Cold War (Ithaca, NY: Cornell University Press, 2002) and Badash, A Nuclear Winter's Tale; as well R. E. Munn, "Discussion," in The Biosphere and Humanity, IIASA Report CP-94–4, (April 1994).

74 For instance, the division between capitalism and communism is not mentioned at all in Anatolii Dorodnitsyn ed., Ekologicheski i demograficheskie posledstviia iadernoi voiny (Moscow: Nauka, 1986), 132.

75 "Otchetnyi balans," RGAE, f.9480, op.12, d.343, l.9.

76 "Poiasnitel'naia zapiska," RGAE, f.9480, op.12, d.343, l.13, 18.

77 Walter Clemens's interview with Alexander King, 4 February 1987 (Walter Clemens, Can Russia Change? The USSR Confronts Global Interdependence (New York: Routledge, 1990), 138); see also Gvishiani, "Methodological Problems of Global Development Modelling," 33.

78 VNIISI was created by the initiative of Gvishiani and in alliance with systems theoretician Boris Mil'ner, economist Stanislav Shatalin and OR specialist Stanislav Emel'ianov. A. Porshnev, "Vklad B.Z. Mil'nera v razvitiiu nauki upravleniia," Rosiiskii zhurnal menedzhmenta 4 (2004): 156.

79 Emel'ianov, 30 let, 132–135.

80 For example, Gvishiani invited V. Sadovskii and Emel'ianov to the meeting with Raiffa at GKNT in November, 1972. RGAE, f. 9480, op.9, d.1716, l.110.

81 RGAE, f.9480, op.12, d.343, l.20; RGAE, f.9480, op.12, d.1865, l.4.

82 Dubovskii, "Global'noe," 56. Given that VNIISI's computer was produced by the major American computer producer, Digital Equipment Corporation, and the embargo on exporting computer technology to the Soviet Union, its road to VNIISI must had been an interesting one. Frank Cain, "Computers and the Cold War: United States Restrictions on the Export of Computers to the Soviet Union and Communist China," Journal of Contemporary History 40, no.1 (2005): 131–147.

83 Gelovani, Britkov, and Dubovskii, SSSR i Rossiya, 16.

84 See Jenny Andersson, "The Invention of the Long Term: RAND, The Commission for the Year 2000 and the Rise of Futurology", in preparation.

85 Gelovani, Britkov, and Dubovskii, SSSR i Rossiya, 18.

86 Stanislav Men'shikov, O vremeni i o sebe (Moscow: Mezhdunarodnye otnosheniia, 2007).

87 Leontief, Carter, and Petri, The Future, iii; Men'shikov, O vremeni.

88 VNIISI was informed by Wilhelm Krelle's study, a joint project between IIASA and the University of Bonn in 1985–1987. Wilhelm Krelle, The Future of the World Economy: Economic Growth and Structural Change (Berlin: Springer Verlag, 1989). In 1984–1989, by Krelle's invitation, VNIISI took part in this project where Brekke, Gelovani and Kay developed scenarios of global development on the basis of American, Soviet and Japanese models (Dubovskii, "Global'noe," 57; Emel'ianov, 30 let,141).

89 Interview 28, 15 April 2013.

90 Gelovani, Britkov, and Dubovskii, SSSR i Rossiya, 64; Dubovskii and Eismont "Long-Range."

91 Gelovani, Britkov, and Dubovskii, SSSR i Rossiya, 7.

92 N. P. Fedorenko, Vspominaia proshloe, zagliadyvaiu v budushchee (Moscow: Nauka, 1999), 387.

93 Interview 31, 10 April 2013.

94 Michael Ellman and Vladimir Kontorovich, eds., The Destruction of the Soviet Economic System: An Insiders' History (Armonk, NY: M. E. Sharpe, 1998), 76–85.

95 Efremenko, Ekologo-politicheskie.

96 D. Chernikov, A. Batizi, N. Volkov and A. Ivanov to Lee (28 November 1986), USSR NMO, IIASA Archives, Laxenburg.

97 Gelovani, Britkov, and Dubovskii, SSSR i Rossiya, 48, 80.

98 Dubovskii, "Global'noe," 56–57.

99 Ibid, 58.

100 Interview 28, 15 April 2013.

101 Moiseev to Gvishiani (1980), ARAN, f.1918, op.1, d.463, l.12.

102 "Zapis' besedy", GKNT (13 April 1972), RGAE, f.9480, op.9, d.1716, l.37.

103 Gvishiani, Mosty, 239.

104 Wynne, Models, 12–13.

105 Donald MacKenzie, Mechanizing Proof: Computing, Risk and Trust (Cambridge, MA: MIT Press, 2001).

106 For more about the history of probabilistic theory, see Stephen Stigler, Statistics on the Table (Cambridge, MA: Harvard University Press, 1999).

107 P. N. Fedoseyev, "Topical Problems of Our Time," in E. P. Velikhov, J. M. Gvishiani, and S. R. Mikulinsky, eds., Science, Technology and the Future: Soviet Scientists' Analysis of the Problems of and Prospects for the Development of Science and Technology and their Role in Society (Oxford: Pergamon Press, 1980), 18.

108 Efremenko, Ekologo-politicheskie.

109 Petrov, Nikita Nikolaevich Moiseev.