

INTERNATIONAL COOPERATION IN BOREAL FORESTS STUDY OF SIBERIA

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Siberian Forests occupy a considerable part of the Asiatic Continent. They constitute nearly 20% of the world forest resources among them 38% of the most valuable coniferous forests. The role of Siberian forests as a biomass producer and carbon accumulator is acquiring a global significance. There are concentrated about 30 billion tons of bound carbon which in case of release may change the state of the atmosphere drastically. It is particularly impossible to assess the character of global changes in the environment and the extent of impact of these processes on the planet biosphere without detailed information on resource and ecological role of Siberian forests.

Preservation of ecological and resource potential of Siberian forests growing in severe climatic conditions and which are subjected to constant anthropogenic pressure is a very complex problem. It can't be solved successfully because of deteriorating of Russian economy, absence of development of infrastructure in most multiforested regions of Siberia and the Far East.

Changes that are taking place in Russia are opening up unprecedented opportunities and at the same time constitute serious danger to the preservation of nature and forests of Siberia and the Far East. Under such conditions it is indispensable to revise policies of the forest sector in ecology, economy and social aspects and to choose the rational strategy of utilization of forest resources. As a result of such revision must be a well-constructed program of forest resources management of Siberia and investment of the forest sector which is based on support of reforms, development of needed infrastructure and implementation of new technologies.

Forest study of Siberia started since the thirties of this century with the commencement of industrial exploration of this extremely rich region. However, the development of planned fundamental exploration started late in the sixties in connection with the foundation of Siberian Branch of the Academy of Sciences of the USSR and creation of a net-work of research institutions in different regions of Siberia.

At present Siberia possesses a huge scientific potential in the field of forest science and great experience in study of Siberian forests. In the city of Krasnoyarsk is located the Siberian International Centre of Ecological and Boreal Forests which was set up on the basis

of Forest Institute SO RAS - the leading Russian research institute of forestry. Over 35 years of intensive work the Institute has accomplished a number of major scientific programs on forests study of Siberia their structure, conditions, features of development, resource and ecological potential. The results of this research are summarized in more than 100 monographs and thousands of articles dealing with the problems of forestry, ecology, biochemistry of woodplants, of forest soil science, inventory and forest management, raw-wood management, forest microbiology, forest fire protection, protection from pests and diseases and other problems.

The International Centre comprises: East-Siberian Sector of the International forest institute (IFI), several Chairs of biology of the Krasnoyarsk State University (KSU) and Siberian Technological Institute (STI). The centre works cooperatively with many Russian institutions dealing with forest problems: Centre of Ecology and Forest Productivity Problems of Russian Academy of Sciences (CEPF)-Moscow; The Ural Sector of the Institute of Forests of Ural Branch RAS-Ekaterinburg; Archangelsk Institute of Forests (AFI); The Far East Institute of Forestry (DalNIILH)-Khabarovsk et al...

The goal of International Centre is to form a data base for assessment of the forest cover dynamic changes in different regions of Siberia, effect of disturbance (natural and anthropogenic); organization and scientific promotion of forest monitoring and forest protection; testing new technologies of utilization and reforestation on the basis of long-term economic projects, taking into account natural features of forests, the set up of international laboratories, expedition and cooperative research, based on the network Siberian expedition stations.

The International Centre works cooperatively with foreign scientific teams and organizations. In the framework of cooperation with the Switzerland Federal Institute of Forest, Snow and Landscape Research (FSLR) and University of State Oregon is being elaborated a project of dendroclimatic monitoring of the boreal forests of Siberia, Canada and the United States. The project promotes the development of methods and programs of statistic and imitation modelling of forming an annual ring depending on conditions of growth and climatic constituents. The utilization of this methods makes it possible to assess the dynamics of wood biomass in different geographical regions of the boreal zone to identify the change of increment depending on major climatic parameters over the past 500 (five hundred) years and describe the history of Siberia in Holocene.

A number of interesting study projects are done cooperatively with the Federal Forest Service of the USA (USDA FOREST service) and its exploration stations. We can refer to the study of carbon budget in boreal forests, impact at global changes on biochemical cycles and productivity of Siberian and North American forests, elaboration of forecasting models for forest vegetation inventory, analysis of forest pests density dynamics. In cooperation with the University of Turku (Finland) are explored biochemical aspects of interaction between

trees and insects. The joint Forestry programs are performed with the Institute of Geography of the Academy of Sciences of China (IGCAS), National University and Department of Forestry and Forest Production of South Korean Republic.

In 1993 on the basis of Siberian International Centre was held an international conference and a major field experiment which served as a foundation for working out the project "Forest Fires in ecosystems of North EuroAsia".

The most large-scale project practically being completed is performed by the International Research Team jointly with the International Institute of Applied Systems Analyses (IIASA) Vienna, Austria. The project was formed on the basis of a special agreement between IIASA and Russian Academy of Sciences. The project is titled: "Forest Resources of Siberia, their management and corresponding socio-economic and nature preservation problems". The major goals of the projects are: analysis of the state of Siberian forests, assessment of their biospheric role and effect on global climatic changes, evaluation of resource potential of the forests and generation of policies of their management, which promote a sustainable socio-economic development of Eastern Regions of Russia.

The work on this major project has started but the scope of works is rigidly limited by financial restrictions. At present a data base is being formed on forest resources of Siberia, infrastructure, industrial and socio-economic factors. It is planned in 1994 to carry out work on evaluation of ecological and resource potential of this forests and study of international and domestic wood market. A prerequisite for developing this project is a substantial financial support both inward and outward.

We think that the project is in accord with the global program for ecological aid of the World Bank "Global Environmental Facilities Program" and "Environmental Management Technical Assistant Project". It is desirable that in the realization of this project should participate scientific structures of NATO within the framework of the program "New mechanisms for Scientific Collaboration between East and West".

The analytical structure of the project is indicated in Table 1. In 1994 will be completed work of blocks 0-1 (generation of data base and pre-feasibility of existing data). Assessment studies completing the analysis and build up of scientific technical policies are planned to be carried out in 1995-1996.

The accomplishment of the project required the organization of new forms of international collaboration and set up of a wide network of Russian Research structures involved in the project. More than 80 specialists from research and project institute of Russia are participating in the generating of data base and information analysis but they are engaged not only in collecting information but are taking part in an active creative analytical experiment. A significant role in the organization of the project is played by IIASA as a specific methodological and organizational centre of international cooperation. In the

framework of IIASA in the Siberian project are working scientists from Finland, Sweden, Germany, Italy, USA, Canada and South Korea. The fulfillment of the project is aimed at two purposes: extension of international cooperation on the basis of utilization of study results of Russian scientists in global assessment of resource and biospheric functions of Siberian forests; the creation of sustainable conditions for incorporating international experience in the solution of concrete problems of socio-economic development of Siberian regions under the conditions of transition to a market economy. It determines the formation of two inter-bound trends: resource-ecological and socio-economic which in aggregate are supposed to give a scientific ground of a sustainable development of the forest complex of Siberia.

In the frame-work of the first trend are being carried the following subprojects.

1. Assessment of the Resources Potential of Siberian Forests.

The goal of the subproject is to form sufficiently full and reliable data base on the forests of Siberia, to give a quantitative estimation of the resource potential of Siberia, to generate forest fund dynamics forecast and building up reasonable strategies of inexhaustible utilization and reproduction of forest resources. The data base is set up within the existing ecological and economic regions of Siberia and includes information of the state forest inventory, materials of forest management, experimental data on phytomass and forest productivity, as well as availability of forest resources within each concrete territory.

The estimation of stock and trade quality of the wood includes definition of volumes of raw wood resources of the main forest species within each forest management enterprise (leshoz) and integrated within each administrative territory (republic, region, kray and ecoregions). A prerequisite of this estimation is working out a new type of commodity tables taking into account international (European) standards of timber in the round. It is very significant while compiling these tables to estimate the spread of defect wood in Siberian forests and make inventory of trade quality of wood as a result of intermediate cutting.

The assessment of non-wood resources in forest ecosystems of Siberia includes the estimation of reserves of technical, wood and medical raw material. It is based on inventory of green biomass, food and medical resources of the forest, reference material and interconnection between types of raw material and taxation characteristics of afforested areas.

While developing the taiga territories it is important to have a concept about ecological and economic accessibility of forest resources. The purpose of this analysis is to exclude from exploitable forest fund those forests fund areas where felling is not allowed

because of ecological considerations (particularly protected forests) hard accessibility or low value of stands.

The estimation of economic acceptability of forest resources is based on the rent estimation of exploitable forests and it envisages calculations of expenses and results in three aspects: harvesting, forest regeneration and transportation (wood delivery to customer). The main characteristics of the forest resources are the following: exploitable (commercial) growing stock (cubm/ha), species composition, site index, average volume of stems relief and soil conditions, distance between the forest area and customers and type of transportation. These characteristics of the forest fund determined the technology of harvesting and types of machines used in overall wood biomass harvesting and delivery to store houses.

The estimation of economic and ecological accessibility of the forest fund is regarded as an important factor of forest utilization under market conditions-sale of forest resources or lease holding or concessions.

A very important sector of the resource part of the project is the prediction of dynamics of the forest fund - long-term and short-term forecasts. This resource of temporal changes of structure and parameters of the forest-ecosystems is carried out as a result of modelling the processes of natural growth and development of woodstands and complex influence of anthropogenic and natural factors. Formalized descriptions of the forest fund as an object of modelling is based on functional classification of forest type of growth conditions, main forest species age-group classes and productivity classes. The changes of structure and state of forest fund is described over time as a result of the forest ecosystems natural successions and anthropogenic and natural influences. The forecast of dynamics of the forest fund is given as a number of possible trajectories of forest stands development corresponding to different strategies of forest utilization and reproduction of forest resources and level of forest protection from pests and diseases.

The predictive estimations of dynamics of the forest fund are used for the grounding of acceptable scales of inexhaustible forest utilization by forest management enterprises and regions of Siberia, agreed volumes of forest utilization and demand for wood raw material, optimal placement of assortment plans for felling for forest enterprises. The latter is carried out as a result of solving mathematical programming problems the functional of which is the maximum income from felling and demand of wood is used as a restriction. The development of a scheme of the transport mastering of territories must be a preliminary stage of solving this task. The selection of acceptable strategies and formation of regional programs of managing and reproduction of forest resources must be based on ecological and economic priorities. Generation of the data base and mathematical apparatus for solving this task for concrete territories and regions - is the most important part of the implementation of the project.

2. Biospheric Role of the Forest of Siberia, their interaction with global changes.

The goal of subproject is to give a quantitative assessment of ecological and social functions of the forest ecosystems, to forecast their conditions taking into account the recommended strategies of socio-economic development and scenarios of global changes by the end of the twenty first century.

The goals of the subproject include:

- assessment of ecological conditions of the main types of forest ecosystems of Siberia within basic territorial units (ecoregions);
- definition of interaction parameters between forest ecosystems and gas composition of the atmosphere;
- modelling the dynamics of forest cover under conditions of global climatic changes;
- working out a strategy of preserving biodiversity and its utilization in the systems of complex nature use.

On the basis of a data base on forest resources and specialized information on their conditions are identified qualitative characteristics of ecological functions of Siberian forests on the global and regional levels.

For development of long-term scenarios of inexhaustible utilizations of forest and retaining the ecological significance of forests are elaborated models with optimal structures of forest ecosystems corresponding to the criteria of a steady development of the biosphere. Special attention is paid to the process of transfer substance and energy and their effect on the atmosphere gases. On the basis of assessment of carbon pool in terrestrial phytomass, soils and marshes are created models of carbon fluxes which reflect natural and anthropogenic processes occurring in forests (forest management activities, forest fires et al).

A very important scientific problem dealing with antropogenic effects on biosphere is a forecast of vegetation cover respodence to climatic changes. One of the methods of solving the problem is the set up and analysis of mathematical models of dynamics of vegetation zones. At present while creating such models are widely used evaluations of vegetation cover distribution by bioclimatic schemes for equal climatic scenarios which are obtained from the general circulation of the atmosphere. The project proposes a new approach based on investigation of dynamics in the shift of vegetation zone boundaries and unequal climatic scenarios which drastically improves the forecast assessments. In the framework of this steady analyzing the parameters of the global carbon cycle is worked out a new approach to imitation modelling and assessment of carbon pools, which is based on the model of dynamics in the shift of bioms boundaries in Siberia under the pressure of long-term and short-term process.

The elaboration of parameters for ecological assessment of forest ecosystems must include the problems of biodiversity. It is particularly important in choosing the ways of forest management and forest industry activities. It is necessary to work out a complex of requirements to the system of use of nature which secure the preservation of biodiversity applied to the conditions of Siberia and give a predicting assessment of this problem by the end of the XXI century despite a variety of management strategies and global changes.

3. Geoinformation system "Forest Resources of Siberia (GIS FRS)"

A very important stage in the implementation of the Siberian project is work-out and put into operation the Geoinformation system which enables an operative solution on different levels in forest management-federal, regional and local. GIS FRS is being worked out as a computerized system of collecting, storing and actualizing factographic and cartographic data on the forest resources and natural-economic features of Siberia; the system of analysis and inventory of these data for the purpose of assessing the ecological potential of Siberian forests and their role in promoting a sustainable socio-economic development of the country.

The functional structure of GIS FRS is determined by the goals solved in the framework of three major subprojects (resource, ecology and economy) and by necessity of providing domestic and international public organizations with information on the current state (condition) of boreal forests. The list of goals being solved in the framework of resource, ecological and economic blocks of the project is given in the technical proposals on the elaboration of the relevant projects.

GIS FRS includes the system of data classification, interpretation and data base. The system of classification and interpretation is worked out in accordance with international and domestic systems with taking into account the structure of the data base GIS.

The composition and structure of technical software of GIS FRS are determined by a necessity of forming, storing and processing huge (up to 10 gbite) factographic and cartographic data base and solving a complex of scientific-technical problems on the main divisions of the project, alongside with the necessity to incorporate GIS into the international computer network.

The perspective of GIS FRS development is closely corrected with the development of Siberian Forests monitoring which is being carried out on the basis of a special project "TAIGA" done cooperatively by Russia and the USA by a joint Russian-American Working group "Science about Earth" in accordance with the decision of the Joint Commission Chernomyrdin-Gore on Energy and Exploration of Outer Space. AVHRR data from polar satellites NOAA, ground data, aerial survey data are supposed to be used in the joint

project. The Installation of station HRPT NASA is planned in the Siberian Centre of study of the boreal forests (g.Krasnoyarsk) for getting satellite data.

The realization of the project will be done in the following directions:

1. Detection and mapping of the active forest fires by using AVHRR data. A task is set to work out and use methods of recording spatial and temporal distribution of the active forest fire on the basis of detection thermal anomalies by sensor AVHRR. The daily monitoring of active fires well give information on the spread broadcast of spots of inflammation and effectiveness of their localization. AVHRR data can also be used for inventory of burned areas, intensity of damaged forest stands and assessment of reforestation processes on the burns. The obtained information is included into the system of federal, regional and local GIS forest fires monitoring of Russia and used for the purpose of optimizing forest fire protection.

2. Assessment of bioproductivity using AVHRR is regarded as an important task of monitoring the forests of Siberia. The expert estimations indicated a wide range in the framework of GIS LS of perspectives for mapping spatial distribution of biomass in the boreal forests and marginal areas,assessment of dynamics of forest vegetation and work out models of productivity of forest ecosystems.

In the GIS structure will be used cartographic and factographic data on ecological, meteorological and vegetation characteristics land utilization and state of forest cover. The analysis of there data will enable to assess the effect of demolishing factors (fires, damage by insect pests, felling et al) and restrict them.

Forest monitoring by application remote sensing envisages a wide spectre of usage data from the Russian, American and European satellites for the purpose of organizing and maintaining an effective system of surveying the forest cover of Siberia. The "TAIGA" project is supposed to be a major stage in solving this problem.



Analytical Structure of the Siberian Forest Study

Components Activities	Forestry	Ecology and Global Change	Industry and Infrastructure	Markets	Socio-economics
Block 0 PRE-FEASIBILITY OF EXISTING DATA + SET-UP OF STUDY	Integrated pre-feasibility study of existing data on all components and set up of the study				
Block I COLLECTION AND ANALYSES OF EXISTING DATA	*Forest Resources *Forest Management *Management Technology *Economic conditions	*Description of ecological status *Global Change status	*Description of existing industrial structure (capacities and technological status) *Description of existing infrastructure	*Description of international markets *Description of domestic markets	* Description of socio-economic conditions *Description of socio-economic indicators
Block II ASSESSMENT STUDIES	Forest Resources Assessment *Allowable cut *Sustainable forest structure *Multiple-use *Protection *Forest management	Ecological Assessment *Sustainable ecological development options *Global Change effects	Assessment of Industry and Infrastructure *Technological development options *Industrial development options *Infrastructural options	Market Assessment *Identification of market possibilities *Possible market strategies	Socio-economic Assessment *Socio-economic development options
Block III INTEGRATED ANALYSES	Integrated analyses of all components based on results from Block II				
Block IV POLICY IMPLICATIONS	*Allowable cut *Forest management	*Strategies for sustainable development	*Industrial strategies *Infrastructural strategies	*Market strategies *Marketing activities	*Socio-economic development strategies