To sustainability in forestry: The Ukraine’s case

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Proefschrift
ter verkrijging van de graad van doctor
op gezag van de rector magnificus
van Wageningen Universiteit,
Prof. dr. ir. L. Speelman,
in het openbaar te verdedigen
op maandag 9 September 2002
des namiddags te 13.30 uur in de Aula

CIP-DATA KONINKLIJKE BIBLIOTHEEK, DEN HAAG

Nijnik, Maria

To sustainability in forestry: The Ukraine’s case / Maria Nijnik
PhD-thesis. Wageningen: Wageningen University, 2002. With ref. – With summaries in Dutch, English and Ukrainian

ISBN: 90-5808-686-0

Subject headings: sustainable forestry, economy-in-transition, the Ukraine

To those whom I care for

ABSTRACT

Nijnik, M., 2002. To sustainability in forestry: the Ukraine's case.

The general idea of the study is to address the current process of establishing new economic relations in forestry-in-transition and assess opportunities for its sustainable development. The scientific value of the thesis derives from the elaboration of multidisciplinary knowledge and the enhancement of practical applicability in a transitional economy of the concept of sustainable forestry development. Taking as an example the forest sector of the Ukraine, the study draws on the state of affairs in forestry that is developing under changing economic conditions, examining failures and new incentives in economic and institutional reforms. The central objective of the study is to determine the appropriate forest policies and economic incentives to improve future output from Ukrainian forestry, while making the sector economically efficient, socially acceptable and environmentally friendly.

The way of the forest sector towards sustainable development is explored by analysing the following sustainability criteria: economics of forest use; forests' contribution to soil protection and carbon sequestration; the institutional framework in forestry and the necessity of its transformation in line with the requirements of the transition economy. The major research questions are: how does the transition to a market economy affect the Ukraine's forestry and what are the opportunities for its sustainable development?

The study provides insights into sustainable forestry development at national and regional levels. Given that the Ukraine is a sparsely wooded country and considering the economic, social and environmental role of forests, the programme of afforestation as a long-term strategy for sustainability is elaborated. The implementation of the programme could enhance economic and soil protective forest functions. The study also reveals how the expansion of forest cover in the Ukraine enables to moderate carbon emissions and what forests' contribution to climate change mitigation could be. Afforestation is seen as a key sustainable forest policy measure if the country receives credits when trees are planted for carbon sequestration, since the currency obtained from such a trade can be used for developing the forest sector, taking into account all other criteria of sustainability.

The research incorporates knowledge from social sciences, forestry and environmental sciences. It follows the semi-qualitative route and applies quantitative models where they are available and relevant. The study employs regression analysis; cluster and factor analysis; simulation and optimisation modelling; and cost-benefit analysis. Special attention in the study is being given to the implementation mechanism and to managerial aspects of the Ukrainian forestry's development towards sustainability.

Keywords: forestry; sustainable development; economy-in-transition; the Ukraine; institutions; multi-functional forest use; timber rotation; afforestation programme; soil erosion; climate change; carbon sequestration; cost-benefit analysis; forest policy measures and instruments.

PREFACE AND ACKOWLEDGEMENT

I[1] was interested in the concept of sustainability in forestry for quite some time, but was following the ecological ideas and my economic background was based on a theory that largely applies to a planned and command-and-control economy. In 1995, I completed a supplementary MSc Course in Environmental Management (EPCEM, the Netherlands) and gained the opportunity to explore in depth the problems that exist in the forest economy. My studies and work at the Institute for Environmental Studies Vrije Univeristeit (IVM/VU) Amsterdam with Harmen Verbruggen and Huib Jansen have given me an opportunity to begin a fruitful research collaboration with the Dutch scholars. In time, their guidance has allowed me to look at the problems of sustainability from a different perspective. The project on sustainability in Ukrainian forestry was initiated with the purpose of integrating economic and environmental aspects of the topic under investigation. My purpose was to elaborate a multi-disciplinary study on sustainability in forestry that is developing under the specific conditions of a transition economy. The work culminated in this thesis.

The research has been developed at the Agricultural Economics and Rural Policy Group (AEP) WU, where I found a stimulating working environment. First and foremost, I would like to thank my promoter and supervisor Arie Oskam, who has provided me with support throughout the project. His constructive and inspiring critiques have contributed considerably in improving the quality of my work and developing my skills as a researcher. I would like to express my gratitude to my colleagues from the Group, the WU, and the IVM/VU for sharing their knowledge and for their support. I am grateful to Theo Hendriks, Andreas Ottitsch, Nico Vellinga, and Frans van der Woerd who have read earlier drafts of separate chapters of the book and provided me with useful comments. In a last round of revisions, Frits Mohren, Heiner Schanz and Hans-Peter Weikard challenged me with many detailed remarks to improve the quality of the thesis. I wish to express special thanks to my adviser from Ukrainian University of Forestry, Stepan Gensiruk, for his inputs in this study. Special thanks go to Kees van Kooten from the University of Victoria, Canada, for his professional guidance and constructive suggestions. Through him, I have substantially broadened my knowledge of natural resource economics. The book Economics of Nature by Kees van Kooten and Erwin Bulte has become a number one book on my desk.

I benefited from discussions with many other people. I will only mention some by name: Vic Adamowicz from the University of Alberta; Kimpton Bradford from Alberta Sustained Resource Development, Land and Forest Division; Wouter de Groot from Leiden University; Petro Lakida from Ukrainian National Agricultural University; Gert-Jan Nabuurs from European Forest Institute and Alterra; Davide Pettenella from Padova University; Oleg Shablij from Lviv University and Anatoly Shvidenko from IIASA. Special thanks to organisations that provided financial assistance for my research and the related travelling: to the AEP WU; IAC; IUFRO-SPDC; Mansholt Institute; NUFFIC; TACIS, etc. I wish to express my gratitude to the Ukrainian institutions where the data was collected. Many thanks to my supporters, Dennis te Beest, Louise Grogan, Frans Oosterhuis, Victoria Shestalova, Tanaqui Weaver, Anastasia and Albert Nijnik who have contributed, directly or indirectly, to the work done. I direct my most sincere thanks to my parents, Ljudmyla Sergeevna and Stepan Antonovych, for their help and moral support.

[1] The author's surname Nijnik has another spelling Nizhnik, which was used until the mid. 1990s.

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1. INTRODUCTION

1.1. Background

1.1.1. Concern of sustainability

Definitions and strategic directions of sustainability have emerged on the grounds of continuous debates of various theoretical thoughts, starting from those of A. Smith, T. Malthus, D. Ricardo, J. Mill and other economists of the 18^{th} - early 19^{th} centuries. Economic growth in the second half of the 20^{th} century meant an expansion in use of natural resources. Their increasing consumption often justified privately in a rational manner, appeared to be socially damaging - compromising the interests of present and future generations (Folmer, 1993). Negative consequences of economic growth, such as water and air pollution, loss of biological diversity, deforestation and soil erosion have provoked environmental awareness among scientists and policy-makers.

The concept of "limits to growth" as it was presented in the book of the Meadows' team and in the Report to the Club of Rome (1972) was an outcome of a deep concern over environmental and resource problems that have become increasingly international. The report further developed a Malthusian position that environmental policies and the promotion of economic growth were incompatible objectives (Pearce and Turner, 1990). The Meadows' team assumed that economic growth measured by GNP implied a similar increase in consumption of resources. According to the Meadows' model, the population and industrial capital would grow exponentially, leading to a similar growth in demand for food and non-renewable resources. The supply of food and non-renewable resources was considered absolutely finite. As a result, exponential growth within finite limits was supposed to lead to a systematic breakdown.

Managerial ideas of the theory of ecological modernisation (the Club of Rome) were largely based on Kondrat'ev's theory of industrial cycles. According to definitions and strategic directions, these ideas come very close to the concept of sustainable development for highly industrialised market economies. Their programme was based on the ideas of a random economic development, on a harmony of limited state administrative regulation with market relations and on technological progress. Its implementation presumed the imposition of ecological limits on natural resource use. Ekins (1993) identified the concept "limits to growth" with ecological limits to the physical scale of economic activities, with limits to economic welfare to be derived from growth of economic activities and also with social limits.

The Rome Club report and the UNEP documents of the early 1970s were followed by the World Conservation Strategy (WCS). The WCS newly acknowledged that the traditional concept of development to satisfy human material needs alone was not sufficient (Robinson, 1993). From the point of view of the WCS, parks and natural reserves, for instance, were not only wildlife habitats but also integral components in national strategies of development. Acknowledgement of the interdependency of conservation and development resulted in the term "sustainable development". The WCS identified its three objectives: essential ecological processes and the biosphere's life support system must be maintained; genetic diversity must be preserved; and any use of species or ecosystems must be sustainable (IUCN/ENEP/WWF, 1991).

The World Commission on Environment and Development tagged the Brundtland Commission, in its report Our Common Future (1987) emphasised a perceived complementarity between growth and environment. It was the first official commission to adopt the notion of sustainable development as a prerequisite for continued societal existence. The Brundtland report calls for "a new era of economic growth - growth that is forceful and at the same time socially and environmentally sustainable" (WCED, 1987). Critical objectives for economic and environmental policies compatible with sustainability were identified as: reviving economic growth; changing the quality of growth; meeting essential basic needs; ensuring a sustainable level of population; conserving and enhancing the resource base; reorienting technology and managing risk; and merging environment and economics in decision-making.

In comparison to the WCS, which focused on the natural world and presumed human dependency on the environment, the Brundtland report focused on environmental problems associated with development. Therefore, economic aspects were seen as crucial. The patterns of production and consumption in the industrialised market economies were considered as major contributors to environmental degradation and, on the other hand, the rights of developing countries and economies in transition to continue their development were recognised. These two aspects predetermined redistribution of the access to the planet's limited environmental space, a necessity to use this space efficiently and sustainably (Folmer, 1993).

The UN Conference on Environment and Development (1992) was the next step in introducing policy changes towards sustainable development. An important institutional innovation to control implementation of Agenda 21 was the newly established Commission for Sustainable Development. New attempts to design policy measures and instruments to promote its attainment have been undertaken. Among important outputs of the conference there were the recognition of the polluter/user pays principle, the necessity of internalising environmental costs, the precautionary approach to environmental change and the use of economic incentives in environmental policy implementation.

1.1.2. Forestry in context of sustainable development

Debates around sustainability in forestry also have a long history. Until recently, apart from scientific debates dating back to the 19th century, the issue of sustainable forestry was hardly given due attention on a policy level. At the First Ministerial Conference on the Protection of Forests in Europe (Strasbourg, 1990), this topic was finally discussed. Sustainable forestry was considered a balanced management of forests that takes into account their role as a life supporting system and the role in meeting the human needs of present and future generations for forests and their products, without threatening their capacity for renewal. The IUCN, WWF and UNEP jointly published the first concrete document not only on the principles but also on the possibilities of joint actions in the environmental field. According to the Caring for the Earth report (1991), the principles for sustainability include to "halt net deforestation, protect large areas of old forest and maintain a permanent state of modified forest".

Internationally, the creation and maintenance of markets for products of sustainably managed forests, together with the assistance to lower-income countries, were identified as priority actions. On a national level, an accent was put on inventorying and protecting of forests, with the involvement of local people in forest policy and management (EPCEM, 1995). The actions to enhance sustainable forestry include the expansion of planted forest area, proliferation of national capacities to manage forests sustainably, the creation of a market for products from sustainably managed forests and more efficient use of wood. The International Tropical Timber

Council (ITTC) of the International Tropical Timber Organisation (ITTO) defined sustainable forest management and decided on a set of criteria for sustainable forestry and on the examples of sustainability indicators.

By the time of the UNCED conference (Brazil, 1992), quite a few countries had developed principles for sustainable forestry. The principles for sustainable forest management were discussed at the Rio conference and an agreement was reached. The debates resulted in a document that reflected the first global consensus towards the problems with forests, namely the Statement of Principles of Forests. The statement "forest resources and forest lands should be sustainably managed to meet social, economic, ecological, cultural and spiritual human needs of present and future generations" has become a guiding document, aiming to contribute to sustainable development and management, and conservation of all types of forests. In the Ukraine, forestry is based on principles, which are called "the principles of wise use of forest resources and forest protection". This study addresses the forest sector of the Ukraine's economy with the special focus on its sustainable development.

1.2. Focus of the Study

1.2.1. Background to Ukrainian economy and its natural resources

The advance of forestry towards sustainability depends on the changes in the economy. Ukrainian economy used to be highly concentrated, inefficiently specialised and integrated with the former Soviet Union. Having had an impressive economic potential, the Ukraine was focused on trade with Russia and East European countries, especially in energy, metallurgy and agricultural products. The Ukraine supplied 20-25% of Russia's black metal, 30-40% iron pipes, etc., in return, it received from Russia such important commodities as oil, gas and timber. Political and economic disintegration, coupled with the abolition of administrative regulation between suppliers and consumers have resulted in the elimination of existing economic relations and co-operation between the enterprises, and have required general adjustment of planning and management systems all over the economy.

In addition to economic disintegration, the country has experienced structural changes, factory closures and high rates of unemployment. Among the reasons for this, are the Ukraine's intensive industrialisation in the past that has promoted a high share of heavy industry in the structure of the national economy, and the development of military production and investment projects at the expense of public services and household consumption. It follows that, while shrinking and transforming its huge military-industrial complex[2], the Ukraine had to expand production for the civil market, seeking opportunities in commercial space technologies and in public services. It had to extend job possibilities inside the country and enhance market competition. The country also inherited from the previous system a long series of problems connected with natural resource use and the environment. They include soil erosion on more than a third of Ukrainian arable lands[3], nuclear contamination after the Chernobyl nuclear

[2] This complex comprised 1300 factories, with the number of employees over 2 million people, or 20% of the industrial labour force.

[3] Annually, 4 million tons of fertile soil are washed out of the fields and average agricultural losses of crops in the western areas of the country exceed 40% (Gensiruk, 1992).

accident on 8.4 million ha of arable lands, water and air pollution and exhaustible exploitation of natural resources such as forests (National Academy of Sciences, 1999).

Due to all these problems, in the course of initial reforms during the period 1990-1995, the Ukraine's economy declined in real terms by more than 10% each year (FAO, 1997). The country was confronted with macroeconomic instability with inflation, hyperinflation and huge price shocks (World in Figures, 1995). Average annual inflation in 1989-1992 was 137% and in 1992-1994 much higher (FAO, 1997). The changes in values of selected available economic indicators describe the state of affairs in the national economy when industrial and agricultural output, national income, food production and living standards have been decreasing (Table 1.1). To avoid social hardship and misery and to prevent political resistance, the Ukraine did not make radical steps toward a market economy. Although private property was legalised in 1992, freeing of prices and restructuring have been slow.

Table 1.1. Rates of Year-to-Year Changes in Values of Economic Indicators

Indicator, %	1989	1992	1995	1998	1999
GNP	-2.4	-9.9	-12.2	-1.7	-0.4
Net fixed Investment	-2.1	-36.9	-29.0	6.1	2.9
Gross agricultural production	5.0	-8.3	-3.6	-9.8	-5.7
Industrial production	3.2	-6.4	-12.0	-1.0	4.3

Source: Rudenko et al (2000) and H. Boss (1993) estimates

The Plan of Action (1993) was intended to cut down the budget deficit substantially and to encourage much faster privatisation (Business Ukraine, 1993). Over its first phase, Ukrainian citizens had access to stock certificates with which they were allowed to purchase shares in government-owned business being sold off to the private sector. In late 1997, already 6,500 medium and large businesses had been privatised. Over the second phase of privatisation, foreigners were allowed to take part in bidding (Woronowycz, 1997). The country had started seeking foreign investment, especially in its oil, gas and electricity sectors. It took steps to decrease dependence on import, particularly of oil, but also of timber. In 1994 -1995, privatisation was intensified in agriculture. Collective farms have been disassembled and private farms have been emerging. The process of transformation, however, is not complete. There are problems related to restructuring in rural areas, starting with the political opposition to the land reform and ending with organised crime during the process of buying/selling of land (Nijnik, 2001).

The steps that have been taken to stabilise the national economy brought positive results (Table 1.1.). In 1996, the inflation rate fell to 40% and the decline in real GDP slowed to 5% (US Energy Information Administration, 1997). The national monetary policy and banking system have become based on the domestic currency, hryvna[4], which has enabled the State to implement its domestic policies, to integrate into international financial institutions and to participate in international trade. In 1997, total direct foreign investment reached 1.65 billion dollars, 19% coming from the USA, 10% from Germany, 9.7% from the Netherlands and 7.9% from Great Britain (US Energy Information Administration, 1997). The government worked out a policy to ensure intensive promotion of agricultural products such as grain and sugar to foreign markets. However, the overall situation has not changed significantly.

[4] Economic crisis in Russia in 1998 influenced the Ukraine's economy and has devalued its currency by more than 50%, despite support from the IMF.

The imposition of strict discipline in government spending and control over widespread corruption are urgently needed in the Ukraine (Talbott, 1998). To bring the national economy up to a current West European standard, it is necessary to retool the industry, reduce energy consumption per unit of output, improve transport and communication and retrain part of the labour force. These measures require tens of billions of dollars for the next few decades. Such financial inputs are not available (Handler and Steinher, 1992).

Nevertheless, the forecast for the future is quite optimistic (Carnegie Endowment, 2001). The Ukraine is the biggest country by area in Europe, 603,700 km^2 with the population of 50 million people (Encyclopaedic World Atlas, 1995). The labour force includes 3.6 million specialists with university degrees, 16.5 million with higher education and 5.2 million people with secondary education (State Committee for Statistics, 1993). The country is rich in natural resources, including coal, natural gas, iron ore, mercury, titanium, magnesium, uranium, kaolin, alumna, peat, salt and graphite. It is the world's leading depository and producer of magnesia, having 30% of the world's reserves, and has one of the most important deposits of iron ore in Europe. It has remarkable endowments of potassium and the greatest European sulphur deposits. The country used to be a large agricultural producer and exporter of sugar, oil, butter, meat, salt and grain. In late 1980s, it was the second in the world in sugar production[5]. Its share in world production of grains comprised 20%[6] and the country held the seventh place in the world in production of wheat (State Committee for Statistics, 1991). The Ukraine's per capita output of main products used to be favourable in comparison with other countries (Table 1.2).

Table 1. 2. Comparison of Per Capita Output of Main Products, 1990

Products	Ukraine	Poland	Hungary	Italy	France
Electric energy, KW hours	5 701	3 843	2 795	3 650	7 431
Petroleum and liquid gas, Kg	105	4	186	78	57
Natural gas,m^3	595	142	581	302	59
Coal, Kg	2 661	6 590	1 894	24	239
Steel, Kg	1 059	399	314	436	344
Tractors/1000 people	2.2	1.3	0.01	1.6	0.4
Paper, Kg	6.8	31	43	80	113
Sugar, Kg	100	45	48	28	65
Potatoes, Kg	373	908	123	42	107
Milk, Kg	471	423	274	200	513
Meat, Kg	86	73	161	63	112
Fish and seafood, Kg	22	17	1.6	10	15

Source: State Committee for Statistics: The Ukraine in Figures (1991)

Though in the course of transition during the 1990s, agricultural and industrial production visibly declined, over recent years, the economic situation has slightly improved. In 2000, the GDP increased by 6%, industrial output was up by 13% and the agricultural sector experienced 7.6% growth. The general conclusion is that the Ukraine, with its rich natural resources and well-educated labour force possesses a good setting for the reforms and has the chance to achieve economic prosperity before long

[5] Sugar beet.

[6] The Ukraine's potential production of grain amounts to 75 million tonnes (National Academy of Sciences 1999).

(Carnegie Endowment, 2001). The way towards sustainable development lies though the market and in finding out paths in resource use that will allow for constant consumption paths per capita.

1.2.2. Research problem and approach

Developments in a particular country, such as the Ukraine, might be sustainable even if forestry declines because of lack of demand for its products and services or due to trade between countries or regions. While regarding sustainable development of the economy it might be rational to import timber and use more lands in rural areas for agricultural purposes, sustainability in forestry, as a lower level in a hierarchy, applies a more targeted approach. Defining sustainability in operational terms does not seem easy. Goldin and Winters (1995) focus on the interrelationship between economic policy, growth and environmental impacts with the link between sustainable resource use and growth remaining the key factor. Equity issues both between and within generations have been discussed extensively in Dasgupta and Heal (1979). The current study employs the concept of weak sustainability, according to which a necessary level of consumption can be guaranteed by holding the aggregate stock of capital constant and allowing for substitutability between its main components.

Sustainable development of forestry is a function of natural, man-made, human and social capital and the concept of sustainability incorporates economic, social and environmental components. In the economy-in-transition, under conditions of market imperfection, non-internalised externalities and weak institutions, these components of sustainability are to be addressed as separate blocks. Concerning the use of natural resources, the goal of sustained yield of timber and of maximum sustained yield was considered a key aim in forestry for centuries. The investment and harvesting problem was firstly solved by Faustman (1849), who has shown that an optimisation of the net present value of all the revenue flows made it possible to calculate the optimal rotation age. This model was extended later by adding to it a flow of non-timber benefits related to the age of standing stock (Hartman, 1976) and by incorporating forest's ability to store carbon dioxide (Van Kooten, et. al, 1995). Howarth and Norgaard (1995) provide a useful analytical framework for examining trade-off between forest use and conservation in terms of intergenerational equity and economic efficiency.

The current research provides new insights into the concept of sustainability by examining multi-disciplinary aspects for sustainable forestry development during the period of transition from a planned to a market economy. The idea of this study is to come up with an operational definition of sustainable forestry within the framework of economic processes that are taking place in the Ukraine. It is equally important for sustainability that economic, environmental and social interests and consequences of forestry development are taken into account, with the shadow priced costs and benefits to be employed in economic analysis of the activities performed in the sector. Sustainable forestry requires optimal allocation of the resources in space and in time, and in the Ukraine, where the markets do not function properly and the prevailing institutions are inadequate, sustainable development requires policy changes towards a market economy.

With this in mind, the criteria and indicators for sustainable development of forestry are worked out. The analysis allows me to reveal that so far insufficient attention has been paid in the Ukraine to such sustainability criteria, as economics of forest use, forests' contribution to global carbon cycle, institutional framework in forestry and the necessity of its transformation in the economy-in-transition. Given that the above criteria require in-depth exploration, they are addressed in the subsequent chapters of the thesis. Forestry is heavily dependent on natural capital that is the core of its sustainability, so particular attention is given to sustained use of forest resources with regard to timber production and indirect user value of forest, i.e. its soil protection role and contribution to climate stability.

1.3. Research Design and Content Overview

In Chapter 2, I describe the structure of forest and wood-processing sectors of the Ukraine's national economy, the current state of forest resources, and the problems facing policy-makers in the period of transition to a market economy. My purpose in this chapter is to review the current state of forestry in the Ukraine and consider possible future directions that, in turn, depend on forest policy and the economic institutions.

In view of the foregoing problem analysis, in Chapter 3, I focus on sustainability as applied to the Ukraine's forestry. I start with examining the existing definitions and approaches towards sustainability. Then differing perceptions of sustainability in forestry are identified. Finally, I add the criteria, indicators and policy measures and instruments for sustainable development of the Ukraine's forest sector. In this chapter, I estimate the equations of the stand growth related to the age of main tree species per forestry zone of the Ukraine. Overall, officially accepted timber rotation ages in commercial forests appear to be longer than simulated optimal rotations. This is indicated by the results of the simulated maximum sustainable yield (MSY) rotation ages for main tree species by zone and is confirmed by the estimates that incorporate prices and costs in the models and account for time span between inputs in production and timber output. Therefore, among the proposed sustainable forest policy measures are optimisation of the ages of timber harvesting with respect to economic objectives and employing a positive discount rate in economic calculations in forestry. I conclude the chapter with managing sustainability in Ukrainian forestry. The following issues are given special interest: How can the concept of sustainable forestry be realised under changing economic conditions? What comprises a basic incentive mechanism of managing forest in a transition economy? Which target groups and policy options are generated? What perspectives and barriers for policy implementation can be envisaged?

A major obstacle to implementing sustainable forest policy decisions is the combination of past exploitation of forest resources with the slow pace of the reforms. The way towards sustainability, therefore, goes through changing institutions, and our purpose in Chapter 4 is to address governance in the Ukraine's forestry by analysing the institutions and investigating their impacts on economic and environmental performance. The research questions of Chapter 4 are: How does the transition to a market affect the forest institutions? What are the trends, impacts and remedies for promoting sustainable forestry development? The attitudinal diversity of forest managers on a market economy and sustainability in forestry is identified and explained by using a Q-methodology approach.[7] The chapter draws on the state of affairs in Ukrainian governance with failures and new incentives in economic and institutional reforms.

[7] Data analysis in Q-methodology involves the sequential application of three sets of statistical procedures: correlation, factor analysis and computation of factor scores.

In view of the Ukraine as a sparsely wooded country and considering the economic, social and environmental role of forests, in Chapter 5 I elaborate in depth on the programme of afforestation, as a long-term strategy for sustainability.[8] The proposition that the scale of erosion in the country depends on the share of wooded lands in rural areas has been put to an empirical test in a regression analysis programme. I examine the relation between the share of wooded lands and the intensity with which soil erosion occurs. The results provide empirical evidence that the distribution of erosion in the Ukraine depends on the share of forest cover and that the establishment of forest plantations is a sound policy measure to prevent the expansion of erosion. The evaluation of the role of forests in soil protection is deliberated as a complement to initial assessment of the benefits from the expanded timber supply out of the projected forest plantations. The chapter proceeds with the cost-benefit analysis of afforestation and offers an LP model that is to serve as an initial basis for policy analysis. According to our projections, the implementation of the proposed programme of tree-planting in the Ukraine will enhance economic and protective forest functions. A brief discussion on managerial perceptions of the creation of forest plantations and land-use changes in rural areas concludes the chapter.

The concern of climate change attracts special attention to planting trees for carbon sequestration. In Chapter 6, I investigate the ability of Ukrainian forests to remove carbon dioxide from the atmosphere, to store it in the form of carbon in terrestrial ecosystems and in this way to alleviate the greenhouse effect. The economics of establishing forest plantations to deal with CO_2 emissions must be investigated as a starting point for substantiating and submitting the afforestation programme for consideration by the world community, raising the option of the Ukraine selling carbon offset services. The programme of afforestation for carbon uptake is to become a key sustainable forest policy measure for the country, if it receives credits for planting trees on its land, because the currency obtained from such a trade can be used for developing the forestry sector, taking into account all other criteria of its sustainability. Thus, the chapter addresses the idea of planting trees for carbon sequestration as a means for Ukrainian forestry to approach sustainable development.

The results reported in this study are integrated in Chapter 7. The major idea of the chapter is that the way towards sustainability in Ukrainian forestry lies through the development of markets, internalising the most important externalities and changing institutions. Chapter 7 gives a comprehensive picture that for forestry to be sustainable, it has to incorporate sustainable timber management based on investment analysis with sustainable management of non-marketable forest goods and the intrinsic values of the forest environment. The study is to contribute to managing sustainability in forestry of the country where crucial economic changes are taking place.

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[8] The idea of afforestation and the comprehensive forestry zoning used as a methodological basis for the programme were proposed by us earlier, see for instance Gensiruk and Nizhnik (1995).

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2. FOREST SECTOR IN THE UKRAINE[9]

The economy of the Ukraine is in transition from a communist command-and-control to a capitalist system. In this chapter, we describe the current state of its forest resources, the structure of its forestry and wood-processing sectors, and the problems facing policy-makers. While the forest sector should be, and still has the potential to become, an engine for economic growth, the combination of past exploitation and the slow pace of economic reform are major obstacles to implementing rational forest policies. Given the right economic incentives and appropriate forest policies, it may still be possible for the Ukraine to improve its future timber supply while enjoying environmental benefits from its forests. However, this requires economic and institutional reforms beyond the forest sector.

2.1. Introduction

Near the end of the first millennium forests covered nearly the entire territory of the Ukraine, but they had been reduced to one-third by the end of the second millennium. In this regard, the Ukrainian experience is no different than that of many other countries. In particular, western Europe and North America (especially the North-eastern and Great Lakes' states of the USA) went through a period of rapid reduction of forested area as a result of economic expansion, followed later by a return to forests as agriculture became a less competitive land use. In the Ukraine, between 1814 and 1914, forested area fell by 30.5%, primarily as a result of economic development during the second half of the 19th century, and the species composition of forest stands worsened. Timber harvesting increased its pace during the first half of the 20th century, and Ukrainian forests continued to suffer from over-exploitation until the 1970s, mainly because of the Ukraine's command-and-control economy.[10] The age structure, density and stand productivity also declined sharply as a result, while floods and soil erosion worsened.

Denudation of the Ukraine's forestlands has come about as a result, first, of the normal forces related to economic development and then of an economic system that paid scant attention to environmental values. It was only in the 1970s that further degradation was neither tolerated nor warranted, as there was no economic surplus left to extract. At that point, the "environmental lobby" within the Academy of Sciences of the Ukraine and the Ukrainian Ministry of Forests was able to pursue a programme of rehabilitation, beginning with the setting aside of 10.8 percent of all forestlands and lowered rates of harvest. However, with the demise of the Soviet empire in the late 1980s and independence in 1991, Ukraine's economy has gone into a tailspin and timber production will be needed as an engine of economic growth. Thus, there exist within the government bureaucracy two camps influencing Ukrainian forest policy—the environmental and the developmental. At the same time, there has been little change in the economy's underlying structure, with decisions affecting the entire forest sector,

[9] The chapter is written as a stand-alone paper "Forestry in the Ukraine: the Road Ahead?" (co-author G. C. Van Kooten) and published in *Forest Policy and Economics* 1 (2000): 139-151.

[10] After WWII, the heavily forested lands mainly of Galich Rus were returned to the Ukraine from Poland and the former Austro-Hungarian Empire. These comprise some 15% of the total area of the country and include the administrative regions of Lviv (25% forested in 1946), Ivano-Frankivsk (36%), Za-Carpathian (48%), Chernivtsy (26%), Rivne (29%), Volyn (17%) and part of Ternopil (12%). As part of the Soviet Union, forests in these areas were immediately subjected to heavy logging.

from the forest through to the final processing stages, made centrally and affected by rampant government corruption (see *The Economist* 1999; Shleifer and Vishny, 1998).

Our purpose in this chapter is to review the current state of forestry in the Ukraine and consider possible future directions that, in turn, depend on forest policy and the economic institutions that the country adopts. We begin in the next section by examining the state of the forests, the tenure system, the balance between growth and harvests, silvicultural investment, and potential timber supply. In section 3, we investigate the state of the wood products processing sector and Ukrainian trade in forest products. Environmental amenities of forests are the topic of section 4. Then, in section 5, we discuss current forest policy and the road that future policy needs to take. The conclusions ensue.

2.2. Forest Management

2.2.1. Forest resources

The forest area of the Ukraine amounts to 10.8 million hectares (ha), of which 9.4 million ha is currently wooded. The standing timber inventory is 1,736.0 million cubic meters (m^3), or some 161 m^3 per ha (185 m^3 per ha of wooded area). Annual growth is some 35 million m^3, so the average mean annual increment (MAI) is 3.7 m^3/ha. Compared with some other European countries, the Ukraine is sparsely forested (15.6% of its territory), with forests concentrated primarily in its western region. On average there are 0.18 ha of wooded area and 21 m^3 of timber per capita (State Committee of Forestry, 2000).

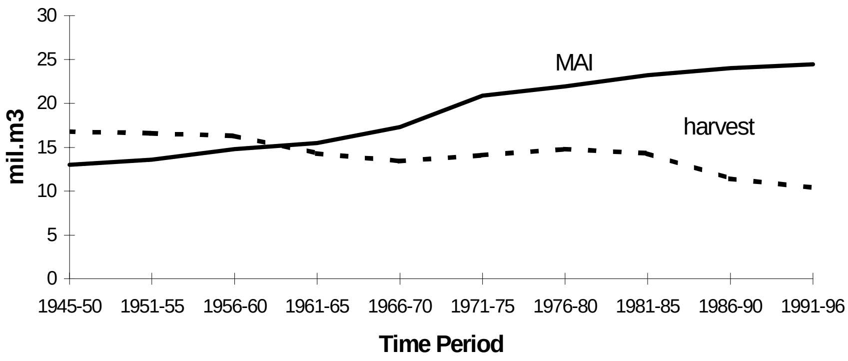
Forest health and vitality have been negatively impacted by the Ukraine's poor overall environmental situation. The Chernobyl nuclear accident affected 2.3 million ha of forest, with about 0.2 million ha being highly contaminated. Forests are also impacted by air pollution in areas around large chemical enterprises and coal-fired power stations. Locally, forests suffer from inappropriate management. As a result, the forest sector has been seriously weakened with regard to the commercial and environmental demands placed on it.

All forests belong to the State, but are divided among various stockholders. Nearly 66% of the forestland (7.1 million ha) is under the direct and permanent management of the State Ministry (Committee) of Forests; this area of forest is referred to as the State Forest Fund. The Ministry of Agriculture controls about 29% of forests and the Ministry of Defence 2%, with the remainder controlled by some 50 public agencies, including municipalities and educational institutions.

The Forest Fund's forestland is divided into protected forests managed for environmental needs and commercial forests. Protected forests (3.41 million ha) comprise green areas around towns and industrial centres (37.6%), protective zones along rivers and around lakes (11.4%), forests to protect fields and prevent soil erosion (30.4%), shelter zones along railways and around airports (6.9%), recreation areas and health resorts (7.8%), and State forest reserves (5.9%). These forests have the most restrictions affecting their use, and the share of protected forests has risen considerably during the last 30 years, indicating a shift in favour of the environment.

Commercial forests comprise 3.69 million ha (52% of the Forest Fund), and are used to satisfy commercial demands for timber. Harvests are regulated so as not to exceed growth (Figure 2.1.)

Figure 2.1. Annual Harvests versus MAI



The total area of Forest Fund lands comprises wooded and unwooded area (Table 2.1.). Both the extent of the Forest Fund lands and forested area are increasing, the latter mainly because of reforestation of denuded forests and of eroded and sandy lands. According to estimates by the National Academy of Sciences (Gensiruk, 1992), average wooded area should increase by a further 25%, primarily by planting trees on lands currently not forested (these lands were likely forested in the past). Such a programme is justified on environmental grounds, including that trees sequester and store carbon.

Table 2.1. Forest Fund Lands, by Type (thousands ha)

		Forested area		Area not forested		
Year	Total area	covered by forests	unclosed stands	recently denuded	roads & canals	swamps, sand & ravines
1951	6274.4	4854.9	723.1	-	369.4	327.0
1956	6088.3	4960.3	251.9	287.2	259.6	329.3
1961	6882.0	5043.1	523.0	288.4	577.7	449.8
1966	7060.3	5387.3	599.9	190.2	503.4	379.5
1975	6884.0	5810.1	278.9	140.0	332.3	322.7
1993	7104.8	6151.4	194.6	102.6	323.6	313.9
1996	7114.9	6186.1	n.a.	n.a.	n.a.	n.a.

Source: Ministry of Forestry of the Ukraine (1993) and State Committee of Forestry (1998).

There are some 25 indigenous tree species in the Ukraine. Deciduous species include oak (*Quercus robur*) and beech (*Fagus sylvatica*), as the most common and valuable, as well as birch (*Betula pendula*), alder (*Alnus glutinosa*), aspen (*Populus tremula*) and other species. Pine (*Pinus sylvestis*) and fir (*Abies lasiocarpa*) are the most common coniferous species. Today both coniferous (softwood) and some deciduous (hardwood) species are used in the pulp and paper industry. The species composition of forests has improved towards valuable species, such as birch and alder, and fast growing ones (e.g., poplar), instead of less valuable ones such hornbeam (*Carpinus betulus*) that are hardly used for commercial purposes. There are also species valuable for furniture, such as maple, cherry and pear trees.

The average age of trees in the Forest Fund is 36 years, with young stands (of up to 20 years) accounting for 55.3% of area (Table 2.2). Excessive harvesting in the post-war period is a major reason why the age distribution of stands is skewed towards the lower ages (see Table 2.2). Forest management now focuses on this problem, since the adverse distribution of stand ages could result in a fall-down in harvests in the near future, with potentially undesirable consequences for the economy.

Table 2.2. Age Structure of Forests by Species, Forest Fund (thousands ha)[a]

Predominant species	young stands	middle age	ripening	mature and overmature	Total wooded area by species
Pine	1282	695	215	49	2241
spruce	305	152	72	41	570
oak	680	797	132	101	1710
beech	177	213	62	101	553
others	249	526	178	124	1077
Total	2693	2383	659	416	6151

[a] Age classification varies across species.
Source: Gensiruk and Nizhnik (1995).

Because the age structure is so young and growing conditions are good, Ukrainian forests are highly productive. Average MAI in the Carpathian forest is some 4.6 m^3/ha. Trends in MAI and standing volume for fully stocked commercial forestlands are generally increasing (Table 1 of the Appendix 2.1). However, there remain opportunities to further increase forest productivity through enhanced silviculture, including fertilising.

2.2.2. Commercial timber production

Timber harvesting differs by forest zones, growing conditions, the state of the forest and the "purpose" of forest stands. In commercial stands of the Forest Fund, harvest consists mainly of clear felling, although commercial thinning has become an increasingly important source of timber, particularly as the availability of mature sites has declined due to over-exploitation (see Table 2.2). Together clear felling and commercial thinning account for 84% of logging output. Reforestation after a principal cut is mandated, although law and practice often differ (Gensiruk and Nizhnik, 1995).

Thinning occurs in both commercial and protected forests, and depends on the age of stands, their condition and species composition. Commercial thinning is carried out several decades before the stand is clear-cut. Pre-commercial thinning and other stand improvements are meant to increase the health of forests and their productivity; they account for nearly 20% of the total volume of harvest (Table 2.3). Thinnings in protected forests account for between 5 and 10 percent of total harvest.

Table 2.3. Share of Harvest by Felling Type, 1956-1995 (%)

Item	1956 1960	1966 1970	1976 1980	1986 1990	1990 1996
Clear felling in commercial forest	72.7	47.7	38.4	39.9	43.0[b]
Thinning in protected forest	7.3	8.2	5.3	6.6	
Commercial thinning	10.5	21.1	35.1	35.3	57.0[c]
Other[a]	9.5	23.0	21.2	18.2	

[a] Includes pre-commercial thinning, thinnings to improve forest health, and harvests of forestland that is diseased, burned or damaged by windthrows.
[b] Sum of clear felling in commercial forests and thinning in protected forests.
[c] Sum of commercial thinning and other.
Source: State Committee of Forestry (1998).

Between 1945 and 1960, harvests exceeded MAI by 2-2.5 m^3 per ha in many areas as forests were overexploited to help the economy achieve its various five-year plans (Figure 1 of the Appendix 2.2). However, harvesting has changed over the last thirty years. As mature forests were overexploited, the Ukraine had to rely increasingly on thinnings of immature stands in order to maintain log output. Annual average harvests from clear felling and from thinning in protected forests decreased by more than 50% (from 11.52 million m^3 to 5.85 million m^3) between 1956-1960 and 1971-1975 (Table 2.3), mainly because the ability to obtain timber from these sources declined. Meanwhile, the volume of commercial timber from commercial, pre-commercial and other thinnings increased by more than fivefold (from 1.51 to 7.75 million m^3).[11]

The uneven distribution of logging activity over the territory of the Ukraine has further threatened forest sustainability. In 1956-1960, timber harvesting was especially intensive in the Carpathians, where fellings exceeded MAI by almost 2 times. This intensified erosion, decreased endurance of spruce stands and contributed to more frequent flooding and windthrows in the mountains. In the next several decades, logging activity in the Carpathians will be reduced, primarily because of a lack of adequate timber, although illegal harvesting continues.

2.2.3. Planning and control

In the past, a number of general economic indicators were used to establish the annual plan of a forestry enterprise (the company responsible for logging and forest management). The Ministry of Forestry (or the Ministry of Forest-Processing Industry in the Carpathians) co-ordinated plans of logging companies, generalised them into aggregate figures and, after adjustments by the State Planning Committee and their verification by the Supreme Council, submitted them downwards to the logging firms. The central planner exercised overall control. The centre also controlled timber procurement.

As an engine of industrial development from 1945 into the 1960s, this policy accelerated the decline of forest resources, beginning in areas where forest resources were plentiful and easy to access, such as the western Ukraine. For the timber enterprise, the main incentives came from the Material Incentives Fund, which rewarded managers based on their ability to achieve stated output and delivery targets at the end of each year. This quantity-driven incentive scheme (see Kornai, 1980) resulted in inadequate attention on the qualitative characteristics of logs. Further, any net earnings from a forestry enterprise accrued to the State. The Sate controlled both cash flows and material/labour inputs and outputs.

Because any excess earnings accrued to the State, managers were unconcerned about costs and innovations that reduced costs and promoted more effective and efficient forest resource use. Risk taking was not rewarded and management was judged only on its ability to fulfill annual production targets. Because the timber resource itself was undervalued, the easiest means to achieve output objectives, at least in the short run of several decades, was to overexploit the most easily available and valuable forest stocks.[12] Essentially fibre input substituted for other inputs.

[11] See Gensiruk and Nizhnik (1995) for additional details concerning data.

[12] See also Shleifer and Vishny (1998) for a discussion of perverse incentives and corruption in the former Soviet Union. The Ukraine has not moved away from such as system in any significant way (see *The Economist* 1999a, c). We discuss this in the case of the forest sector in sections 3 and 4 below.

2.2.4. Silvicultural investment

Managers of logging firms in the Ukraine have no incentive to invest in silviculture, so it needs to be mandated. According to the National Academy of Sciences (1990), total silvicultural expenditures should increase by 40% by 2010, the average annual value of standing forests should rise by 43%, and the structure of forest stands has to be improved. For example, in 1990 some 40,000 ha of forestland was fertilised, but the Academy felt this had to be doubled by 2010. It also felt that forestry enterprises should satisfy more completely their requirements for energy, herbicides, fertilisers and other material inputs out of earnings. That is, silvicultural investment needed to be treated as a cost of production that had to be covered from "sales" of timber to the processing sector. Only then would it be possible to increase the productivity of forest stands. The Academy's view does not accord with standard investment theory. If forestry is to be competitive with other land-use activities, such as agriculture, silviculture needs to earn a future return (which might include recreation and other non-timber amenities) that exceeds the cost of the investment, and should not be considered a cost of current production.

According to Academy projections, forest replanting needed to become 90% mechanised and felling operations 70-95% mechanised by 2010. This would require a 33% increase in capital investment in forest operations between 1986-1990 and 2005-2010, and a reduction in labour inputs by 6%. In its projections, the Academy expected timber output to rise by 4.5% as a result of technological progress and more efficient use of wood (i.e., less waste). The projections by the National Academy of Sciences can only be considered optimistic, especially since there already exists a gap between forestry policy and practice.

2.3. Wood-processing and Trade

In 1997, the Ukrainian forest sector (forestry and wood-processing together) accounted for 2% of GDP, 2.2% of industrial output, and 5.0% of the industrial labour force. Like the forest (logging and management) enterprises, wood-processing firms are owned by the State, although these are slowly to be privatised. One step in this direction has already been taken. Until 1996, the two sectors operated together under the Ministry of Forests, but they were separated in an attempt to increase efficiency in both sectors.

2.3.1. Wood-processing sector

Wood-processing is divided into three types of enterprises: pulp and paper, wood-processing, and paper and cardboard manufacturing. The main products are sawnwood, building components, wood-based panels, wooden boxes, plywood and furniture. Building construction and maintenance accounts for 67% of domestic consumption of wood products, followed by industrial needs (20%) and fuel (10%). Further, there has been a slight increase in the share of wood used for consumer goods (Andrusyshin, 1994).

Statistical data for the Ukraine is difficult to obtain because the country became independent only in 1991. Some data are available from Ukrainian sources. Data from the Food and Agricultural Organization (FAO) of the United Nations are also available and, while also based on Ukrainian sources, are at least consistent in international terms. With respect to international trade flows, the FAO (1999) data are consistent with trade flows reported by other countries.

Production data of Ukrainian origin provide a picture of change in the output of major wood products from 1970 to the present (Table 2.4).

Table 2.4. Production of Main Wood Products, 1970-1997

Production	1970	1980	1990	1997
Sawnwood (million m^3)	10.4	7.1	3.8	2.1
Plywood ('000s m^3)	195.4	173.3	162.2	28.8
Chipboard ('000s m^3)	345.0	860.8	1171.0	202.3
Fibre board (million m^3)	4.5	26.1	35.6	14.0
Wood pulp (Mt)	131.2	105.1	54.7	8.5
Paper (Mt)	187.4	209.0	369.2	86.6
Cardboard (Mt)	326.0	347.5	542.8	177.0

Source: Academy of Sciences (1990 and 1998)

These indicate that there has been a significant reduction in output of all products since 1990. Prior to that, there had been increases in the output of wood-based panels (particularly fibre board) and paper and cardboard; sawnwood and plywood both declined significantly in the two decades prior to independence. The FAO data are presented in Table 2 of the Appendix 2.1. These indicate some discrepancies from those in Table 2.4, particularly with regards to wood pulp output. The data in Table 2 of the Appendix also include roundwood production: some 8.2 million m^3 of industrial roundwood are produced annually, of which 4.4 million m^3 are softwood logs.

The change towards greater output of various types of wood-based panels and paper-cardboard production since the 1960s is indicative of increased commercial processing of lower-grade fibre, by-products and hardwood species. This corresponds with a shift in reliance of harvests from mature to immature stands, the latter via thinnings. The focus on lower-grade fibre has also offset the declining timber harvests of the 1970s and beyond.

Since the early 1990s, the situation within the forest sector worsened. Financial instability, inefficient and inadequate tax collection, budget deficits, insecure economic relations, and corruption within government led to a decline in the economy that impacted the forest sector. Further, as traditional trading within the Soviet bloc has come to an end and with it greater reliance on world prices, the wood products' sector is confronted with wood costs that are too high in light of the sector's inefficiency. High material and energy inputs due to out-of-date technology have resulted not only in relatively high prices, but also low quality products that are difficult to sell domestically and internationally (see subsection on trade). As a result, between 1990 and 1997, overall output fell by 250% and employment by 160%, as did labour productivity. The output of sawnwood declined by 45%, chipboard by 83%, fibre board by 61%, wood pulp by 74%, and furniture production by 78%.

The Ukraine produces annually about 7.5 million m^3 of wood wastes, with about one-third resulting from logging and two-thirds from wood-processing. Only 30% of logs are converted to wood products, with the remainder constituting smaller pieces of wood (40%), sawdust (20%) and chips (10%). Some one-half of what is not converted to wood products is used to make wood pulp (small pieces and chips) and fibre board (chips and sawdust), with the remainder used as fuel wood, primarily by households. Half a million cubic meters of wood are simply lost, and this wastage has been increasing during the last decade.

The Ukraine produces half as much chipboard per thousand m^3 of timber as Finland, one-sixth as much fibre board as Sweden, one-eighth as much plywood as

Italy, one-tenth the cellulose of Austria, and one-twentieth as much paper and cardboard as Germany (Bondar, 1982). More than 25% of wood is lost due to poorly developed systems for protecting wood during storage from biological and physical agents of deterioration. Additional fibre is lost due to a failure to collect properly wood residue and waste, and out-of-date wood-processing technology and technique. All of this is a consequence of an economic system that provides inadequate incentives for innovation and quality improvements, and lack of access to capital markets. Thus, wood-processing enterprises experience difficulties in obtaining machinery (Table 2.5), but they also have no incentives to produce high-quality outputs (see Ahlander, 1993; Shleifer and Vishny, 1998).

Table 2.5. Number and Age of Machinery in Wood-processing

		Operative using time			
Machinery	Number	less 5 years	5-9 years	10-19 years	over 20 years
Woodworking:	78612	14830	20331	23219	20232
-rotary saws	16719	3119	4403	4907	4290
-band and scroll saws	2873	295	542	754	1282
-frame saws	2888	603	846	845	594
Paper making machines	51	2	1	9	39
Cardboard-making	17	1	2	1	13

Source: Andrusyshin (1994)

The problem is particularly acute in wood products as, in a command-and-control system that emphasises advanced industrial output, the forest sector is hardly a high priority for being allocated machinery since wood fibre can easily be substituted for capital. As a result, sawmill equipment that has been in use for more than 20 years comprises about 30% of the total, while machinery in the pulp and paper industry in 85% of cases exceeds the norm (Table 2.5). Things only became worse as a result of the general decline of the economy after independence.

Until 1991, prices of wood products were fixed at an artificially low level. Since then, prices have been dictated by the market, but, along with devaluation of the currency (Ukrainian *karbovanets* or Krb, also known as the *hryvna*), this has created high inflation and uncertainty (Table 3 of the Appendix 2.1). The uncertainty has created additional problems for the sector.

2.3.2. Forest products' trade

Before independence, 38 million m^3 of timber were consumed annually, with about 15 million m^3 (about 40%) coming from domestic forests and the remainder (23 million m^3) from Russia. As a result of the economic crisis, domestic timber demand has fallen to 9.3 million m^3, while domestic roundwood supply has fallen to 10.1 million m^3 (FAO 1999). Some 10% of this difference has recently been exported at prices well below the international level (mainly due to barter trade), while processing enterprises lack sufficient financial resources to function properly.

Exports of forest products are regulated by quotas and export duties, which are set by the Government, while barter remains a prevalent means of exchange, leading to the possibility that products are sold at below international market prices. Future access to western markets could be limited by timber certification that requires the Ukraine to satisfy certain sustainable forestry management criteria.

Although Ukraine's harvest levels are below what is biologically feasible (see Figure 2.1), wood product imports exceeded exports by more than US$150 million in 1998 (Figures 1 and 2 of the Appendix 2.2). Paper and paperboard constitute the largest component of both imports and exports, but the quality of imported products exceeds that of exported ones. The same is true of sawnwood and panels. Further, industrial roundwood constitutes a large component of exports, but is insignificant as an import item. The Ukraine also imports wood pulp. The overall picture that emerges from trade data supports the earlier observation that the Ukraine is producing low-quality wood products for export, while importing higher quality ones. A major destination of exports is Germany, while Russia is a source of imports. Further, the Ukraine is running a current account deficit in an area where, if appropriate policies were enacted, it could run a surplus.

2.4. Non-timber Benefits of Forests

The Ukraine's forests are also a source of non-timber forest products, such as mushrooms, berries and greenery, as well as providing use (recreational) and non-use (environmental) benefits. Each of these must be considered in the development of appropriate forest policy.

2.4.1. Recreation

It is estimated that some 25 million people annually take part in out-door recreational activities in the Ukraine's forests. Forests that are valuable for recreation are classified into 265 recreation zones covering 1.3 million hectares. Natural parks such as the Carpathian and Shatsk are popular recreational destinations. The Carpathians were assessed as a recreational region of international significance. The main benefits of forest-based recreation are related to health, as evidenced by the many health resorts. However, forest recreation and access are generally free, and this has threatened local forest ecosystems.

2.4.2. Forest policy and the environment

Forests are also important because of their environmental amenities. Pollution absorption, watershed and soil protection functions of forests are key factors of ecological stability. Forests remove carbon dioxide from the atmosphere and act as a carbon sink, thus mitigating climate change, and they provide scenic and biodiversity benefits to society.

The Ukraine's main forestry policy document, the Forest Code (1994), identifies the soil-protecting, water-conserving, air-cleansing and health-giving functions of forests as being more important than commercial timber exploitation. The Forest Code lays out the main objectives of forest management as (Samoplavsky, 1997):

- to increase the area covered by forest in every biogeographical zone of the country;
- to conserve the biodiversity of forest ecosystems;
- to increase forest ecosystems' resistance to negative environmental factors, climate change and anthropogenic disturbance;
- to ration use of forests in order to satisfy timber and wood product demands; and
- to expand forest cultivation in the Steppe.

These objectives are also contained in various environmental policy documents.

The above objectives are a wish list for the environmental lobby within the Ukrainian bureaucracy and cannot realistically be used to guide forest management without greater knowledge about production possibilities and the trade-offs to be permitted among the various uses of the forest. For example, what does it mean to ration use of forests to meet fibre demands? Does this mean more or less harvesting of timber? Does it mean that more will be spent on silviculture and tree-planting in order to meet this objective? Does it mean that the environment will be sacrificed and, if not, how will the forest be managed for multiple use? Clearly, one needs to know the underlying goals and to provide signals to forest managers as to how various objectives are to be met. The best signals in this regard are prices because the state is unlikely to know the trade-offs and production possibilities in advance.

As a result of the 1992 Convention on Biological Diversity, particular attention in the Ukraine is paid to the nature protection. The natural flora of the country includes almost 30,000 species, of which 5,000 are higher ones. About 600 species of plants are rare and endangered (Hardashuk and Nizhnik, 1995). To improve the situation, about 1.4 million ha of protected area of national significance were created, with strictly protected areas comprising 30%. These include biosphere and natural reserves and parks. Today, 10.8% of forests are reserved, but this comprises only 2% of the territory of the country. The immediate objective is to increase protected area to 5%, with all of the Ukraine's biogeographical zones to be represented.

There exist over 2 million ha of marginal agricultural land, wasteland, areas along rivers and canals, and other lands that can be planted with trees. The National Academy of Sciences estimates that, by planting these areas, there will be environmental benefits (including carbon uptake) and an increase in timber availability by 25-30%. Much agricultural land has been degraded as a result of years of state control. Planting trees on this land is one of the most reliable protection measures against erosion and further land degradation. Finally, forest regeneration is another principal means by which the Ukraine hopes to attain sustainable forestry.

The Ukraine is also developing international co-operation in both forest protection and afforestation as a means to mitigate global climate change.

2.5. Forest Policy in the Ukraine: The Road Ahead?

The Ukraine is a country in transition from a Communist, command-and-control economy to a market economy, but the transition is extremely slow and even seems to have stalled (*The Economist*, 1999a). State-owned firms still dominate and the heavy hand of regulation remains. This is particularly the case in the forest sector, where both forest enterprises and wood-processing companies are state owned. The sector is extremely inefficient and things are not about to change until the entire economic and political system is revamped.

There are 260 enterprises involved in the management and harvest of forestlands, while there are nearly 12,500 sawmills and more than 700 more specialised wood-processing enterprises (including pulp and paper mills). Opportunities to achieve economies of size are lacking, both in supplying timber and in wood-processing. The government has placed responsibility for these two sub-sectors in separate ministries in an attempt to improve productivity and inject market forces, and slowly permit privatisation of wood-processing companies. However, the government is unwilling seriously to privatise the sector because this would lead to large-scale restructuring that would result in the loss of thousands of jobs. The environmental lobby (particularly within the National Academy of Sciences) also opposes outright privatisation of the forest-level enterprises because it fears this would result in neglect of the environment.

While loss of jobs is inevitable, fear that the environmental programme described in the preceding section will be scuttled is unfounded.

The state of Ukraine's forests worsened under communism because natural resources, here agricultural and forest resources, remained undervalued. In order to meet output targets under communism, managers of state farms and forest and wood-processing enterprises substituted the undervalued natural resources (soil and wood fibre) for other, harder-to-obtain inputs. Thus, forests were degraded and/or converted to agriculture, while agricultural soils were depleted. If enterprises in the primary sectors are privatised, and land and other markets are allowed to operate without interference so that owners can collect the economic rents, then natural resources will become more valuable to users and the substitution of natural resources (fibre) for other inputs (capital) will become dearer.[13] As a result, much land that is currently in agriculture will revert to forest, because forestry will be more competitive as a land use than agriculture (van Kooten and Folmer, 1997). Empirical evidence supporting this contention is the existence of nearly 2 million ha of abandoned land in the Ukraine, land that had been used in a wasteful manner and is now no longer capable of producing adequate returns to agriculture. It lies unused because there exist no property rights that would protect individuals from investing in its improvement (e.g., by planting trees). Under a free market, economic theory would predict a partial afforestation of marginal agricultural land in the Ukraine, a process that could be aided by the sale of carbon credits.

A second factor that will prevent degradation of forest ecosystems is forest certification. If the Ukraine is to continue exporting wood products into Germany and other developed countries, it will in the future have to guarantee that such products come from forests that are sustainably managed. Certification will involve inspection by international agents who are less likely to be affected by the desires of local politicians.

Finally, as the economy improves as a result of a successful transition to a market economy, there will be greater demand for the non-timber outputs and amenities provided by forest ecosystems. There will be increased demand for forest recreation, as well as the environmental services of forests, such as provision of biodiversity. Supply of some non-timber outputs/amenities is complementary with normal commercial forest operations, or at least is not negatively impacted by them. Some others can easily be provided by modifying forest management slightly, and it is only necessary to provide the needed incentives (e.g., allow forestland owners to collect hunting and other recreation fees), or are addressed as part of forest certification. Nonetheless, there will remain some environmental benefits that can only be provided by setting aside certain forest ecosystems, and doing so is a legitimate role for government. Decisions concerning protected areas should be made as part of a political process and, once made, should be modified as little as possible to avoid both uncertainty for the forest industry and/or the eventual demise of protected forests (Sinclair, 2000). Extant Ukrainian economic and political institutions cannot guarantee that encroachment of protected areas will not occur.

The situation within the forest sector—inadequate investment in forest resources, illegal harvesting and sale of timber, waste, out-dated equipment, and so

[13] If privatised firms continue to be regulated so that they provide what the politician desires, then inefficiencies are likely to continue, as has been demonstrated by Shleifer and Vishny (1998, pp.151-81).

on—is not unlike that elsewhere in the economy. While it is possible, in principle, to design appropriate forest policies for addressing the problems in the sector, it is impossible to do so until the larger, national economic problem is addressed. Only then will it be possible to balance the demands of forest protection against those of development.

2.6. Conclusions

The Ukraine is a country in transition from a Communist command-and-control to a market-democratic economy. Essential components of this transition include price liberalisation, stabilisation and privatisation. If the forest sector is an example of how the rest of the economy has handled this transition, it must be considered a failure. Log markets do not exist as timber is sold to wood processors at prices set by the State. Inflation is rampant as indicated by a comparison average US dollar and domestic currency prices for four forest products from 1990 to 1994 (Table 3 of the Appendix 2.1), although inflation has abated significantly since then. Finally, there is no intention to privatise forest enterprises and there has been little privatisation of wood-processing firms.

In addition to these three steps, "an essential part of the transition to capitalism is the transition of government" (Shleifer and Vishny, 1998, p.229). This includes replacing obsolete human capital—local and national politicians and managers of state firms (p.246). Otherwise, the politicisation of the economy and continued predatory role of the state will continue, resulting in inefficiency and (perhaps illegal) exploitation of natural resources, particularly forest resources.

There remains but one conclusion: forest policies to bring about sustainable forest management, and a competitive wood-processing sector cannot be implemented until the economic transition to capitalism is complete.

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Appendix 2.1.

Table 1. Mean Annual Increment and Standing Inventory by Species, Forest Fund's Commercial Forest (m^3/ha)

Year	Mean annual increment	Average stock of stands			
		average	coniferous	oak & beech	Other hardwoods
1956	2.98	123	142	116	73
1966	3.22	120	137	115	73
1976	3.72	139	155	134	92
1993	3.96	170	196	155	120
1996	4.00	185	n.a.	n.a.	n.a.

Source: Gensiruk and Nizhnik (1995) and State Committee of Forestry (1998).

Table 2. Annual Production of Forest Products, Ukraine, 1997-1998

Item	Production
Woodpulp (Mt)	35,000
- Mechanical wood pulp	10,000
Paper & Paperboard (Mt)	261,000
- Newsprint	8,000
- Printing & writing paper	29,000
Industrial Roundwood (m^3)	8,242,000
of which softwood	4,371,000
- Sawlogs & veneer logs	6,208,000
of which softwood	3,250,000
Chips & Particles (m^3)	930,000
Fuelwood (m^3)	905,000
Wood-based Panels (m^3)	275,000

Source: FAO (1999)

Table 3. Average Prices of Selected Forest Products

Products	Units	1990	1992	1993	1994
Roundwood	krb/m^3	30.0	1430.0	9380.0	420000.0
	US$/$m^3$	53.6	37.9	9.9	70.4
Sawnwood	krb/m^3	60.0	3270.0	21200.0	1225000.0
	US$/$m^3$	107.1	86.7	22.4	205.2
Particle board	krb/m^2	1.5	70.0	240.0	16400.0
	US$/$m^2$	2.7	1.86	0.25	2.74
Packaging	krb/m^3	100.0	4500.0	27490.0	1386000.0
	US$/$m^3$	178.6	119.3	29.0	232.2

Source: Andrusyshin (1994)

Appendix 2.2.

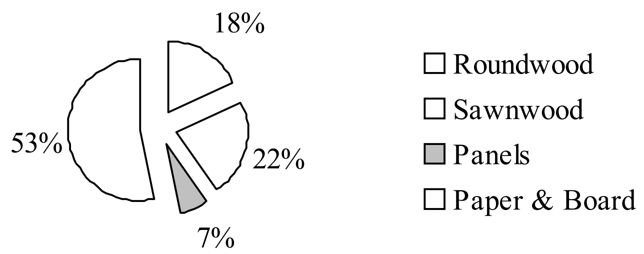

Figure 1. Wood Product Exports by Category, 1998 (Total=$116.4 million)

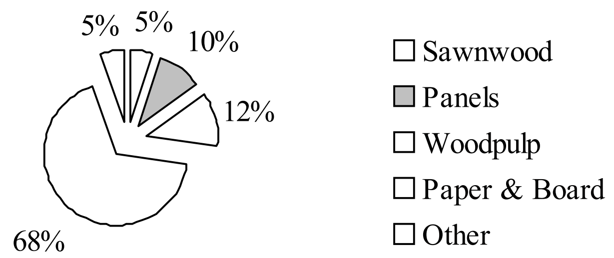

Figure 2. Wood Product Imports by Category, 1998 (Total=$271.8 million)

3. SUSTAINABILITY IN UKRAINIAN FORESTRY[14]

3.1. Introduction

Sustainability in forestry is defined to include economic, social and ecological components. Economic sustainability, which receives most attention here, addresses the Ukraine's forest economy where, with the emergence of market relations in timber production and trade, the investment analysis is becoming an important element in decision-making. The social component of sustainability largely concerns institutions and organisations discussed in a separate chapter. Ecological sustainability relates to the resilience of the ecological system, its integrity and its ability to maintain a continuous stream of ecological services. An important task is to balance economic criteria of sustainability with social and environmental considerations. This is to be solved under conditions of proper institutions and a well-functioning market, when the most important externalities in the forestry sector are internalised.

The principle for sustainable development presumes the ability of human society to live within the limits of the Earth (WCED, 1987). Despite the variety of ideas on sustainability, the concept mainly focuses on non-declining over time consumption or human well-being per capita (Pearce and Turner, 1990). It contains at least one of the following components: condemnation of rapid population growth and awareness about the potential to maintain economic growth in the face of resource scarcity; apprehension about the welfare of future generations; and concern with the long-term health of the environment (Van Kooten and Bulte, 2000). Today, the majority of scientists are optimistic about the future prospects of economic development with "Ricardian scarcity" being offset by technology and compensatory market processes. Moreover, in contrast to the idea of the 'limits to growth' (Meadows et al., 1972) and in support of the optimistic point of view on economic development, the concept of Environmental Kuznets Curve (EKC) has been put on the agenda (Grossman, 1995). The EKC idea is that environmental damage first increases with income, but after a certain point it declines. This does not mean that we should not be concerned about the future development. Deep concern about sustainability remains and is caused by three key aspects. The first aspect is an economic one. The second ethical aspect presumes moral obligations for the present generation regarding future ones. The third argument comes from an ecological point of view that it is intrinsically undesirable to threaten critical capital that comprises non-substitutable natural resources, e.g. biodiversity (Perman et al., 1996).

In this chapter, I examine theoretical aspects of sustainability in forestry, which is developing in specific political and economic conditions of transition from a command-and-control to a market economy, from an authoritarian to a democratic society. The purpose of this chapter is to deliberate the sustainable forestry concept and to examine perspectives and barriers, measures and instruments, regarding its implementation under the conditions of transition. In Sections 3.2.1 and 3.2.2, I discuss

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[14] Adapted from this Chapter a paper, Managing Sustainability in Ukrainian Forestry is published in the book: H. Essman and D. Pettenella (eds.) *Forestry in Transition. Redefining the Role of Forestry Sector in Ukraine*. Padova University, 2002: 25-45.

The paper Economic Considerations on Sustainability in Forestry is in: *Ecological Economical Doctrine: Origins, Problems and Perspectives*. The IUFRO, 2002: 60-65.

the existing definitions and approaches towards sustainability with an attempt at combining economic, social and environmental perceptions of the subject under investigation. Then, in Sections 3.2.3 and 3.2.4, I identify differing perceptions on sustainability in forestry and clarify that efficient, resource carrying and long-lasting timber production is its important prerequisite. Finally, I suggest the criteria, indicators and policy measures for sustainable development of the Ukraine's forest sector.

3.2. Sustainability in Forestry: the Ukraine's case

3.2.1. Economist's concept of sustainability

The diversity of views on sustainability (over 60 definitions, Pezzey 1997) makes it difficult to clarify the concept itself and a unique one hardly exists. The majority of economic approaches focus on intergenerational transfer of wealth or natural resources (Table 3.1.)

Table 3.1. Neoclassical and Neo-Malthusian Views on Sustainability

Neo-classical	Neo-malthusians
1. Focus is on the margin. It is here that the decisions are made. The scale of the economy is irrelevant.	1. Focus is on large ecosystems, possibilities for irreversibility. There are scale effects.
2. Monetary values are used to measure changes in environmental quality.	2. Monetary valuation is opposed where threatened ecosystems are concerned.
3. Discounting and present values are used.	3. Discounting is opposed. The emphasis is on the future.
4. Prices are important, signalling scarcity and encouraging substitution and technological innovation. Technological change is a powerful factor.	4. Prices do not reflect reality, because of the externalities. Technological change is unpredictable and unreliable for solving future problems.
5. Utilitarian value system is employed.	5. A value system must come from outside ecology.
6. The current generation owes the future generation opportunities equal to its own. Necessity to maintain a non-declining aggregate capital stock or to have adequate investment to compensate the future for its use or degradation.	6. Safeguarding the functioning of large-scale ecosystem satisfies concerns about intergenerational fairness. Preservation of variety of ecosystems, aesthetic services is what matters for the future.
7. Attempts are made to measure and compare the well-being of various generations.	7. Rights of future generations trump the mere enjoyments of current generations, which come at the expense of the future.
8. The Safe Minimum Standard of Conservation allows trade-offs.	8. The Precautionary Principle permits less scope for balancing costs and benefits.
9. Economists employ steady state models that assume equilibrium.	9. Models focus on resilience and non-equilibrium dynamics.
10. Property rights of individuals are prominent. Government’s role is to set and enforce the law and to correct externalities.	10. Individualism is seen as a source of environmental degradation. State intervention is needed to protect ecosystems.

Source: Van Kooten and Bulte (2000)

The economist's conceptual approaches reflect the ideas of neo-malthusian and neo-classical economists, and the debates between them are ongoing with regard to substitution possibilities between natural and reproducible capital. The neo-malthusians, adhering more closely to ecologists' ideas, argue that population growth and production growth, and the scarcity of the resources will inevitably lead to unsustainability of economic development (Barbier et al., 1994). The neo-classical point of view is that the elasticity of substitution between natural capital and reproducible capital is positive and thus the global economy is sustainable with respect to aggregate output growth. The neo-classical economists argue that as a resource becomes scarce its price goes up. This results in substitution of the resources and in technological progress (Scott and Pearse, 1992). The approach presumes that economic growth can be sustained with a continuous decline in non-renewable resource stock, and that technological progress will enable the society to shift in a long-run to a renewable substitute of the non-renewable resource. Among the economist views on sustainability the following basic concepts are recognised (Perman, Ma and McGilvray, 1996):

1. A sustainable state is one, in which utility/consumption is non-declining through time. The approach considers a Rawlsian ethical framework (equal utility allocation on each generation of people over time) to be the appropriate one for developing principles of inter-temporal distributive justice.
2. A sustainable state is one in which resources are managed so as to maintain production opportunities for the future. This means that composite capital stock is non-declining over time. Substitution possibilities between natural and human-made capital are important in this respect.
3. A sustainable state is one, in which the natural capital stock is non-declining through time. This approach presumes that natural capital is essential to production and is not substitutable.

The first and second definitions of the concept of sustainability are closely connected with each other. The unconvincing point of the first definition is that, in cases when the concept concerns utility, the realising of sustainability becomes problematic, because utility is difficult to measure for the future generations, and because it is affected by various factors, which are often interdependent. Another weakness of the first definition is that it does not entail any requirements regarding the initial level of the non-declining consumption, though this level could be low. It follows that in cases when the initial level of consumption is insufficient, the society aims at improving its well-being over time rather than at keeping it intact. Then, the objective of maximising inter-temporal social welfare makes sustainability compatible with optimality.

Concerning sustainability in forestry, as long as the earnings from timber harvesting are invested and shared between generations, sustainability is compatible with economic efficiency. However, the objective of maximising the net present value of benefits does not always correspond to sustainability. Maximising the net present value involves a comparison of the net benefits from postponing harvesting with the net benefits from harvesting timber and investing the profits. This objective of maximising the net present value from the forests with a moderate growth often promotes volumes of harvesting higher than the net growth of forest stands. It follows that, as long as all forest values can not be included in economic valuations, in search of sustainability in forestry that is to be economically efficient, the establishment of fast-growing forest plantations instead of natural forests is encouraged. However, the establishment of fast-growing plantations threatens sustainability in forestry, regarding such criteria of sustainability, as biological diversity, health and vitality of forests, etc. Thus, this practice definitely contradicts with the strong sustainability ideas. Sometimes also, it contradicts with efficiency, because it enlarges the costs related to care and protection of monoculture forest stands, which are less stable biologically, and because these costs are not always included in the evaluation process. Hence under conditions of non-internalised externalities, which is a characteristic feature of market failure, the first definition could restrict consumption to consumption of goods and services, leaving ecological component of sustainability underestimated.

The second concept called weak sustainability is related to the first definition, because the way toward sustainable development lies in finding out paths in resource use that will allow for constant consumption paths per capita. The concept is practicable and according to it, necessary consumption level can be guaranteed by holding the aggregate stock of capital constant and allowing for substitutability between its main components. The approach is based on the ideas of neo-classical economists that the answer on the question of whether the state of the economy is sustainable, depends on whether the total stock of capital is non-declining in time and is sufficient to meet the needs of present and future generations. The concept allows future generations to possess a no less effective set of capital, than is in the possession of the current generation and to derive from this stock of capital at least the same level of consumption.

If we consider a very simple economy, in which just man-made capital and natural capital, or natural resource, are inputs in production:

$$Y_t = Y(Kn_t, Km_t),$$

where

Y is output/income;
Kn is resource input;
Km is input of man-made capital,

the question whether there exists a positive and sustainable level of consumption depends on the substitution possibilities between man-made capital input and natural resource.

For simplicity, let us consider three options:

1. $Y_t = aKn_t + bKm_t$

the resource is inessential in production and the finite nature of its stock is not a constraint on production and consumption. With sufficient man-made capital any level of consumption could be attained.

2. $Y_t = \min(aKn_t, bKm_t)$

the natural resource is essential in production and there does not indefinitely exist a sustainable positive level of consumption. In cases one and two, the conclusions are straightforward.

3. $Y_t = AKn_t^a\ Km_t^{1-a}\ ,\ 0<a<1$

constant returns to scale production function, for which the resource is essential in production and there exists a possibility that a positive level of consumption will be indefinitely sustained. There will be sustainability as an outcome if the society follows a particular saving and investment rule (Hartwick, 1977). Then, sustainability can be realised by always saving the rent arising in the efficient depletion of the natural resource and investing it entirely in man-made capital. If saving and investment are as required for sustainability, total wealth will be constant, and the sustainable consumption level will be an equivalent of the interest on the constant wealth. This is called the Solow and Hartwick Rule and is a basic framework for the economic theory of sustainability. The idea is that a general capacity to produce can be passed to future generations.

However, efficient depletion of natural resources may be too fast for sustainability, causing the current resource price and rent to be lower than what is sustainable. In this case even full investment of the resource rent will not ensure enough capital formation for sustainability. Thus the Rule is a necessary but not a sufficient condition for maintaining constant level of consumption (Van Kooten and Bulte, 2000). Though there are weak points in this criterion of sustainability, as there is no justification of the initial level of the non-declining consumption and very strong assumptions are required for the validity of this rule, investment is a crucial point for achieving sustainable development. The aspect that concerns sustainability is to allocate resources correctly between investment and consumption, and to make correct trade-offs between investments in natural capital, nature conservation, and reproducible capital, human-made capital and knowledge. While criteria and indicators of sustainability have been broadly and often critically discussed in literature (Vellinga and Withagen, 1995; Van den Bergh and Verbruggen, 1999; Slangen, 1999; Van Kooten and Bulte, 2000), the "constant capital" rule remains the most relevant economic definition of sustainability.

As follows from the rule, a key condition for sustainability in forestry is the availability of the capital that enables the state to maintain economic development for the future. The capital includes natural (*Kn,* as forest resources), man-made (machinery, financial assets, etc.) and human (technical and managerial expertise) capital. Yet, I consider social capital (*Ks*) also a very important asset. It is decisive for the country-in-transition where institutional transformation and societal changes play a very important role[15]. Thus, sustainable development of Ukrainian forestry is a function of natural, man-made, human and social capital $Y(Kn, Km, Kh, Ks)$, and the concept of sustainability incorporates economic, social and ecological dimensions.

- Economic dimension concerns the ability to maintain sufficient production capacity of forest to meet current and future demands for timber and non-timber forest products and services through using the resources efficiently.
- Social dimension concerns institutions as embodiments of a comprehensive system of new rules and organisations that is to be placed under the obligation to turn the forest sector towards sustainability. This also adds in socially acceptable equity in the distribution of incomes and benefits from the forest, including those of a cultural and ethical nature.
- Environmental dimension of sustainability concerns the ability to maintain sufficient forest resources (productivity of forests, health and vitality of ecosystems, etc.) and to enhance the environmental benefits of forest.

Under conditions of market imperfection and non-internalised externalities, three dimensions of sustainability are often addressed as separate blocks and then supposed to be balanced. Sustainable development, therefore, revolves around the question of the extent to which markets are functioning in delivering appropriate signals to achieve the optimal allocation of the resources. The development of a market economy in the Ukraine is seen as a way towards sustainable development of its forestry sector. It is important here to emphasise that there are various taxonomy levels of sustainable development: sustainable development of Ukrainian economy that can lead to a decreasing forestry and sustainable development of forestry. Although sustainability for the Ukraine is a broader concept and I largely focus on the concept of a lower level, as it applies to forestry, these two concepts are interrelated.

[15] These issues are considered in Chapter 4.

Sustainability requires that the value of net change in the total capital stock (K) has to satisfy the conditions defined by Pearce and Atkinson (1995), which with the inclusion of social capital become:

$$dK/dt = d\,(Kn + Km + Kh + Ks)/dt \geq 0,$$

where $K = Kn + Km + Kh + Ks,$

Kn natural capital;
Km man-made capital;
Kh human capital;
Ks social capital.

Since, net capital accumulation:

$$dK/dt = S(t) - d\,K(t),$$

where *S(t)* gross savings;
d depreciation rate on capital stock,

the condition for sustainability becomes:

$$S(t) - dK(t) \geq 0$$

Assuming that knowledge and skills, and social capital do not depreciate:

$$S(t) - dm\,Kn(t) - dn\,Km(t) \geq 0$$

Dropping time and dividing by income Y, gives a condition for sustainability and provides us with a sustainability indicator:

$$Z = S/Y - dm\,Kn/Y - dn\,Km/Y \geq 0$$

An economy is sustainable, if it saves more than the depreciation on its man-made and natural capital.[16] This indicator is an index of weak sustainability, which is employed in the current study.

The third definition of the concept advocates for what is called strong sustainability. It comes close to ecologist's ideas and could be misleading since does not promote economic growth. Beckerman (1994) considers this approach "morally repugnant and totally impracticable", given the poverty and environmental problems in which large part of the world's population live. This concerns the Ukraine for which the priority objectives are to be economic. The strong sustainability concept could be relevant when forests, providing important non-substitutable resources and services for the society, are in danger of depletion. Then, their non-substitutable resources and services are called critical capital, which includes endangered species and habitats, etc. The strong sustainability paradigm requires that the development in forestry should not lead to a decline of the stock of these resources over time. The non-substitutable goods and services of forests (critical capital) fall out of the spectrum of this study.

Considering timber management, the strong sustainability concept supports the idea of maximum sustainable yield that does not take into account economic requirements. This is critically discussed in Section 3.2.3. The economic requirements are very important for Ukrainian forestry since meeting economic objectives will bring financial gains to the sector and will promote sustainable development, also regarding its social and environmental dimensions. The weak sustainability concept that considers

[16] Further, if in analysing human and social capital, it is possible to conceive that there might exist a "depreciation" of knowledge, in that if it is not upgraded over time, it might become obsolete. This also concerns social capital. Theoretically, we may talk about its "depreciation" when with societal changes old institutions become dysfunctional, but they tend to persist, as it is shown for the Ukraine in the following Chapter 4.

economic objective crucial and allows for trade-offs between various components of sustainability is pertinent, therefore, for forestry-in-transition.

3.2.2. Ecological ideas on sustainability

Putting even stronger constraints on economic growth, than does the idea of strong sustainability, the ecologist's approach relates sustainability to the resilience of an ecological system, its integrity and ability to maintain production of ecological services (Robinson, 1993).

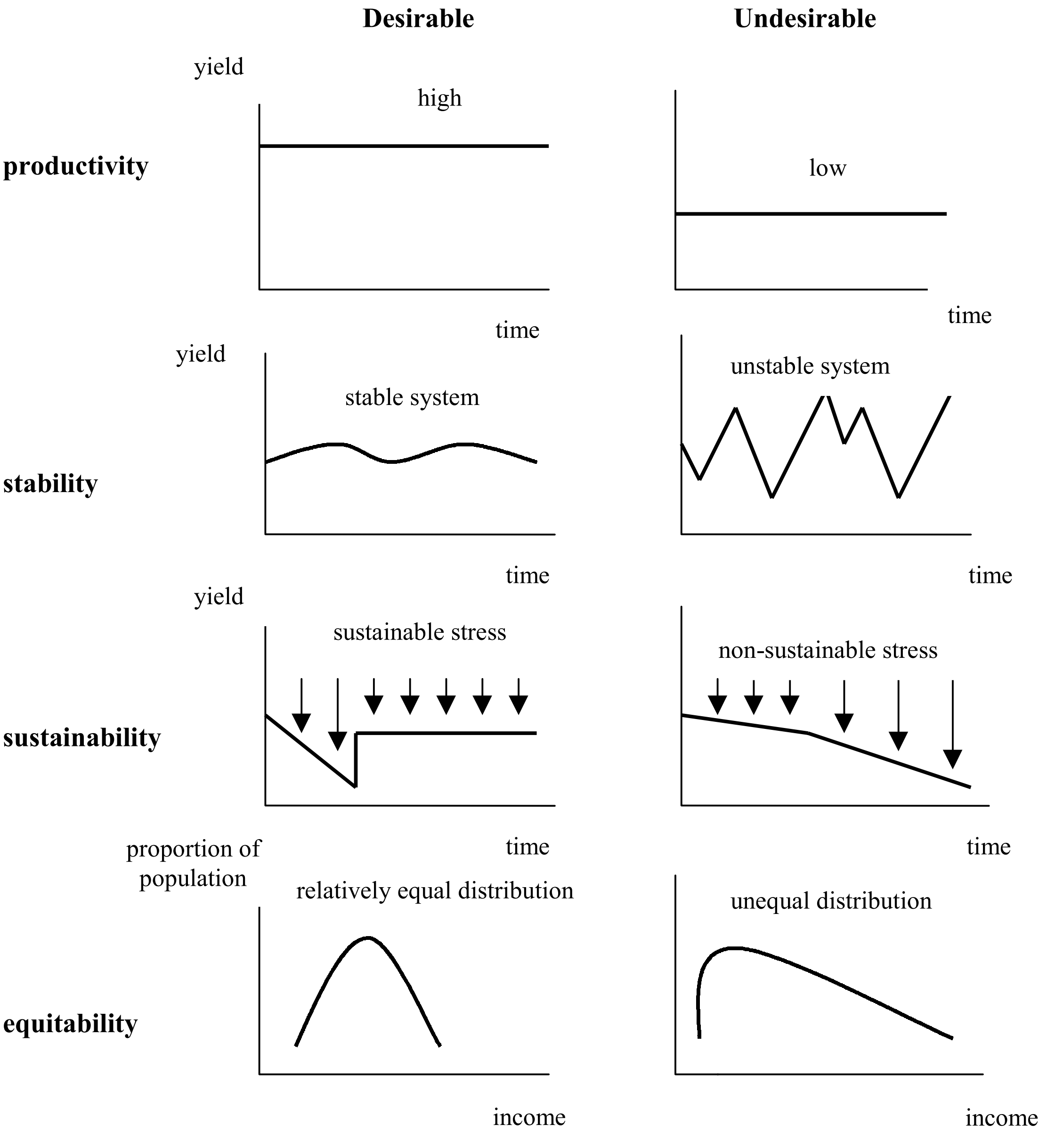


Figure 3.1. Sustainability Criteria by Conway (1985)

According to the ecological ideas of the Caring for the Earth document (1991), the term sustainable use of renewable resources, as regards forests, means that their harvesting should be within their capacity for renewal. Sustainability of the natural systems can be assessed in terms of four properties (Figure 3.1). They include productivity, measured in terms of yield or net income; stability of yield or net income;

sustainability of yield or net income and equitability in terms of income distribution. This idea, which considers economic, social and ecological dimensions of the ecological sustainability of agricultural systems is relevant also for forestry.

However, Conway's concept (1985) deals with the ability of the system to withstand stress and to recover from it afterwards, while a threat to sustainability does not always result from the accident, like that of Chernobyl, but it may develop gradually. Threats to sustainability can be diverse in content, time dimensions and levels of hierarchy. Often, impacts on forest systems are permanent and they are not definitely exogenous (Tisdell, 1993). An ecological approach does not allow for trade-offs between characteristics of productive systems and between policy alternatives. Considering sustainability in forestry, one must evaluate an acceptable loss of certain species or environmental impacts. The ecologist's concept of sustainability experiences real difficulties in bringing in one dimension the variety of aspects in order to evaluate and compare the policy outcomes. The ecological approach is qualitative rather than quantitative, and it does not have a quantitative method for a good measurement and comparison, such as the net present value used in economics. Generally, it has no strict spatial and scale dimensions, no empirical substantiation and no real reference to a specific product and service, such as the forest sector of the economy.

According to Pezzey (1997), to address sustainability the following rules that are in concordance with Barbier’s (1989) conditions for sustainability can be helpful:

- For a given technology, the rates at which renewable resources are to be used must always be less than the available flows.
- Renewable resources must not be driven to extinction - a safe minimum standard of conservation must prevail (Ciriacy-Wantrup, 1968).
- Waste flows must be kept below the assimilative capacity of the environment.
- The stock of non-renewable resources should not be depleted as long as the economic benefits of maintaining this stock at some (minimum) level exceed the costs of doing so.
- Excessive governmental intervention in the economy causes development that is not sustainable, and this should be prevented.

Following Van Kooten and Bulte (2000), failure to realise the above rules need not be catastrophic, but it makes standards of living in the country considerably lower. This has occurred in the Ukraine. The first rule suggested by Pezzey (1997) was not present in the forest practice until the middle 1970s, while the last rule on the excessive governmental intervention remains relevant today. All at once, the concern over the state of the environment, which was degraded to a large extent by the absence of these two basic rules, resulted in the prevalence of the ecological ideas on sustainable forestry in the Ukraine. Sustainable forestry is seen as a silvicultural activity that maintains and protects natural resources. The ecological approach to sustainability in forestry hampers economic development and provides additional evidence in favour of the concept of weak sustainability as the most appropriate approach for the forestry-in-transition.

3.2.3. Sustainable management of forest resources

Considering sustainable forestry a lower level of hierarchy within the development of economy, sustainability in forestry is quite a broad concept by itself. It is broader than efficiency since it takes into account such aspects, as social acceptability, moral and ecological considerations. Regarding its economic dimension, sustainability is already a more comprehensive concept than efficiency, because sustainability requires resource carrying and long-lasting production. A basic requirement of sustainable forestry is obtaining a constant or an increased flow of wood from a forest whose natural structure and species composition are maintained to some degree (Rice, Gullison and Reid, 1997). Under conditions when growth rate of the forest is larger or equal to the interest rate, weak sustainability is compatible with efficiency. Sustainability in forestry can exist only if the returns to it exceed those of alternative uses of the land and exceed the costs of forest management (Pearce, Putz and Vanclay, 1999). In such a way, sustainable forestry is embodied in the practice of sustainable timber management where management regimes allow for economically efficient production and where forest regeneration is an important forestry activity. Yet profit maximising objectives do not always correspond to efficient behaviour, because when amenity values are large and not captured by the forest owner, inefficiently short rotation of timber is promoted. This is important to stress in view of the forestry-in-transition where rent seeking objectives have to be balanced with the goal of a long-lasting production, which is to be brought about by forest regeneration.

For many years forest scientists have been dealing with the concept of sustainability in forestry, which was based on the idea of maximum sustained yield (MSY). This concept considers a sustainable state as one in which resources are managed so as to maintain a sustainable yield of resource services. The natural stock is held constant and delivers a constant flow of resource services over time (Perman et. al., 1996). Forestry in Germany and Austria[17] where this idea came from has not started through investment on bare lands. Forests were available and had to be managed in a sustainable way. Therefore, MSY that corresponded to an objective of the highest revenue was appropriate for the forestry of the 19th century, under conditions, when the main question was not, whether to invest capital in forestry or in some other economic activity, but where to find the best allocation of the existing capital stock within the forestry sector.

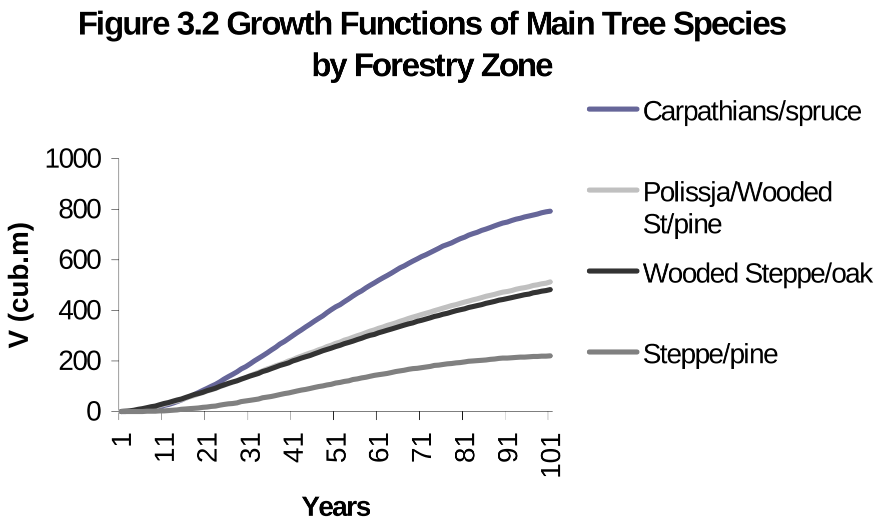
Maximisation of mean annual increment V(t)/t with respect to t was the goal of sustainable forestry at that time, with the first-order condition: $dV(t)/dt = V(t)/t$. However, harvesting at MSY will not always be sustainable in the long-run due to natural fluctuations of the stock (Conrad and Clark, 1987). Another and even more important shortcoming of this idea was a 0% discount rate employed in calculations, a rate that does not account for a time span between inputs in production and timber output. Also, prices and costs were not incorporated in the concept and therefore the scarcity of investment was not taken into account. Consequently, that practice led to solutions not really useful to economic decisions in forestry.

The Ukraine's forestry has inherited from the Austrian practice the idea of MSY, which has become consistent with the command-and-control economy. After Ukrainian forests had been over-exploited, during 1950-1960s, and there was no economic surplus left to extract, economic considerations in forestry ceased to be rudimentary. Since the middle of the 1970s, the forest sector has been focused officially on forest ecological functions. Economic objectives in forestry were addressed via plans, such as that of maximising the volume of certain timber assortments, but not via considering net present value or forest rent. Today, the idea of maximising the average annual cash flow remains popular in the Ukraine when both revenues and costs of timber harvesting stay relatively low. Officially accepted rotation ages of forest stands in the Ukraine are roughly that of MSY. This observation is proven by calculations on MSY done for main

[17] Also, in Western Ukraine that was a part of the former Austrian Empire.

tree species per forestry zone of the Ukraine. The zones were defined via a spatial classification of forest management (Gensiruk and Nizhnik, 1995). This is described in Chapter 5 and is used as a methodological setting of this study. Data on growth rates of main tree species per zone is that of the State Committee of Forestry (1987).

Different tree species possess different functional forms of stand growth, which I estimate by using the data of the continuous records of the Forest State accounts. The statistical analysis (with all parameter estimates statistically significant at p=0.05) has resulted in the equations for the estimates of the stand growth related to the age of trees of the first site classes (the most productive in particular conditions). The average growth functions of main tree species per zone of the Ukraine are shown in Figure 3.2.



On basis of the equations for the estimates of the stand growth for main tree species per forestry zone of the Ukraine, I compute the ages of timber harvesting based on maximum sustainable yield, and later on, the Faustman and Fisher rotation ages (Table 3.2.). In practice of forest management, the optimal rotation ages could diverge substantially from these rough estimates. The figures obtained in this study are initial approximations of the rotation ages and are to serve rough indicators for policy changes.

In the Carpathians, the following functional form of tree growth is defined for spruce (m^3): $V(t) = 0.159\ t^{2.240}\ e^{-0.018t}$

Maximisation of mean annual increment with respect to time results with the MSY rotation of spruce stands of 70 years.

The growth function of pine in the Polissja and Wooded Steppe is (m^3):

$$V(t) = 0.704\ t^{1.648} e^{-0.010t}$$

Similar calculations result in 65 years MSY timber rotation for pine of the first site class in the Polissja and Wooded Steppe.

The growth function of oak in the Wooded Steppe is determined as:

$$V(t) = 1.043\ t^{1.515}\ e^{-0.008t}$$

and thus a MSY rotation age of oak appears to be 64 years.

For pine in the Steppe, which growth function is defined as:

$$V(t) = 0.006\ t^{2.847} e^{-0.026t},$$

the maximum sustainable yield rotation age appears to be 71 years.

During the transition period, with the elimination of the former centralised supply of timber and with the emergence of market relations in timber production and trade, the investment analysis is becoming an important element in decision-making. The high interest rates with comparatively low costs of timber harvesting per unit of effort have changed former views on forest as an ecological asset. Thus, the existing attitude on sustainability in forestry based on MSY revealed above has to be adjusted.

If the objective of forest operation is to maximise the net benefits from a one-time timber harvesting, the Fisher equation is employed:

$Max_t\ PV(t)e^{-rt}$ would result in the first order condition: $PV'(t)e^{-rt}-rPV(t)e^{-rt}=0;$ $V'(t)/V(t)=r;$ for spruce in the Carpathians e.g.: $V'(t)/V(t)=2.240/t-0.018;$ and the Fisher rotation age is 39 years. Then trees should be harvested at time when an increase of their value, or a rate of their growth, is equal to the rate on alternative investments. The Fisher rotation ages (Table 3.2.), however, are not pertinent when sustainability in forestry is considered and when future harvests are to be taken into account, as well as, forest regeneration.

Faustman (1849) gave the first economic formulation of the harvesting problem correct enough to be used in economic calculations in forestry. He considered even-aged stands planted on bare lands, took into account the investment and argued that the optimisation of the net present value of the revenue flows of timber

$$Max_t \{PV(t)\ e^{-rt} - C\} / (1 - e^{-rt})$$

would result in definition of an optimal rotation age. The first order condition for the optimal rotation age is:

$$P\ V'(t) / (P\ V(t) - C) = r / (1 - e^{-rt}),$$

where

P stumpage price per unit of timber (fixed), for simplicity it is assumed that the cost of harvesting is a constant marginal cost that can be subtracted from price of logs to obtain a net price or stumpage price (P);

$V(t)$ volume of timber over time;

C regeneration costs (fixed);

r interest rate.

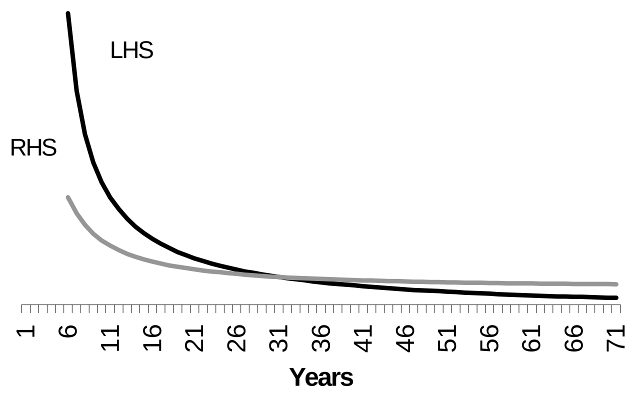
$PV'(t) / (PV(t)-C)$ represents a relative growth rate in net harvest revenues (Bowers and Krutilla, 1985).

In the models, I employ average values of prices and costs for main tree species per forestry zone defined in Chapter 5 (Table 5.7).

The right hand side of the Faustman equation (RHS) *is* $r / (1 - e^{-rt})$. Its left hand side (LHS) is $PV'(t) / (PV(t) - C)$. The optimal rotation age lies at the intersection of two curves that represent the RHS and LHS of the Faustman equation and this can be presented graphically (Bulte, 1997). The estimations are carried out by forestry zone. The RHS under the same discount rate of 4% remains unchanged for all forestry zones of the Ukraine and is $0.04/1\text{-}e^{-0.04t}$. For the Carpathians, for instance, where spruce has the following functional form of tree growth (m^3): $V(t) = 0.159\ t^{2.240}\ e^{-0.018t}$, the LHS of the Faustman equation is: $\{5*(2.24/t-0.018)\ 0.159\ t^{2.240}\ e^{-0.018t}\}/(5*0.59\ t^{2.24}\ e^{-0.018t} - 7.5).$

Graphical representation of the Faustman equation for spruce is provided in Figure 3.3. The LHS estimates and the graphs for the other tree species by forestry zone are computed similarly.

Figure 3.3. Faustman Rotation Age of Spruce, r=4%



Concerning harvesting of spruce stands in the Carpathians, and considering 4% discount rate[18], the age of timber rotation recommended by Faustman's rule is that of 32 years. The optimal rotation age is the age when marginal benefits of postponing harvesting are equal to the marginal cost of its delay. It is low enough, because of low regeneration costs and high interest rates and due to good growth of spruce in the zone. High ages of timber rotation of pine in the Steppe can be explained by relatively low growth rates of pine and rather high regeneration costs (*C*=50 €/ha). The regeneration costs of oak in the Wooded Steppe are also high (about 33 €/ha) to compare them with 7.5 € per ha, for spruce in the Carpathians.

By analysing the intersection of the curves when values of costs, prices and interest rates are different we may observe the state of art in forestry and define various strategies. High interest rates and more sophisticated silvicultural decisions tend to reduce ages of timber rotation. By rising costs via taxes and by introducing quotas it is possible to regulate harvesting in the opposite direction. The computed above MSY rotation ages for main tree species per zone and the estimates that account for time span between inputs and output in production and incorporate prices and costs in the models (Fisher and Faustman rotation ages) are shown in Table 3.2.

Table 3.2. Timber Rotation Ages of Main Tree Species by Zone, Years

Forestry zone, species	Officially prescribed	MSY	Fisher r=4%	Faustman r=4%
Polissja, pine	81-90	65	33	23
Wooded Steppe, pine	81-90	65	33	24
Wooded Steppe, oak	91-100	64	32	65
Steppe, pine	81-90	71	43	70
Carpathians, spruce	81-100	70	38	32
Crimea[19], pine	121-130	n.a	n.a	n.a.

Source: Data on prescribed rotation ages is that from the State Committee of Forestry (1998); the rest estimates are computed on basis of the data from the Committee.

Presented in the table officially stipulated ages of commercial timber harvesting of main tree species by zone are comparable, but higher than the MSY rotation ages. The results of the analysis indicate that in the Ukraine, officially recommended timber rotation in commercial forests is longer than simulated optimal rotation. This does not mean, however, that the ages of harvesting should be exactly the figures defined above.

[18] The rate of discount largely influences the results. This will be discussed below.
[19] The figures where not computed, because commercial timber cut is prohibited in the natural reserves.

The most important reason why it is not so is that the models do not account for multi-functional use of forests (Perman et al., 2000).

Multi-functional use of forests is the objective of Ukrainian forest policy (The Forest Code, 1994). This recognises that in addition to main forest function of timber supply, a variety of goods and services can be produced from the same land and such management can increase the net value of the forest (Panayotou and Ashton, 1992). Non-timber forest production and forests' use for recreation are consistent parts of the Ukraine's forest sector. People have open access to forests, and non-timber forest products are an important source of their consumption and additional income. Environmental role of forests and their soil protection and carbon sequestration functions are essential. Option, existence and bequest values (Krutilla, 1967) that individuals attach to biodiversity are considered priorities in the Ukraine's forest policy (The Forest Code, 1994). Under such circumstances, neither Fisher nor Faustian rotation, which incorporate only timber production, lead to optimum solutions and to highest social benefits.

In order to take into account multi-functional use of forests, the Faustman model was extended into the idea of maximisation of the net present value of the revenue flows from both timber and non-timber forest outputs (Hartman, 1976; Calish, 1978 et al.). When forest's ability to accumulate carbon and in such a way to prevent greenhouse effect is incorporated into the model, it is further extended. In most cases the rotation ages of stands in forests that are used for multiple purposes appear to be higher than that of commercial forest plantations (Van Kooten and Bulte, 2000). However, sometimes they become lower, as with regard to forage production (Bowers and Krutilla, 1985).

The results of calculations provide evidence that the economic objectives of sustainable forestry are not met in the Ukraine and that the rotation ages in commercial forests (the second group of forests) are to be lower than officially stipulated ages of timber harvesting. They are to be comparable with the Faustman rotation ages. The MSY rotation ages are relevant for the forests of the first group[20] (Table 3.2). In the future, when the most important externalities are to be taken into account in economic calculations, the rotation ages will be adjusted more precisely to the requirements of the weak sustainability in forestry.

3.2.4. Choice of discount rate

It is important to distinguish theoretical aspects of using the appropriate discount rate considered optimal for a society under specific conditions, and a rate of discount based on a private decision driven by the actual behaviour of protagonists in real situations. At the level of the society, positive interest rates have two sources. The first represents social time preference. That is, we have to discount the future because of diminishing marginal utility of consumption. Under this assumption, one more unit of consumption in the future is less valuable than one more unit of consumption today. The second source is the productivity of capital or its social opportunity cost. This means that if certain resources are invested instead of being consumed, it is deemed that these resources will provide in the future a higher level of consumption than if they were consumed (Pearce and Turner, 1990). With perfectly functioning markets, social rate of time preference equals social opportunity cost of capital, since there is no logic in undertaking the investment unless future benefits offset the social rate of time

[20] Major functions of forests of the first group (roughly 50% by area) are environmental (The Forest Code, 1994).

preference. In the actual world with imperfect markets, the situation is quite different and a choice is to be made.

In forest economics, because many effects are long-lived and growing forests give benefits far away into the future, discounting is very important. The main problem that economists are faced with here is a shortage of information on future effects of current forestry activities. Uncertainty relates to future demand and supply of the timber, to institutional setting of the resource management, to the forest stock and its reproduction, technological advance, etc. Therefore, one more justification for discounting relies on the uncertainty about upcoming events and their outcomes. On one hand, since the growth of the economy is affected by random shocks, the uncertainty about the growth of incomes would induce people to invest more for the future. This precautionary effect provides an argument to reduce the discount rate (Gollier, 2002). The concept of intergenerational equity works in the same direction as Clark's concern about the depletion of forest resources (1993) and Ramsey's notion (1928) of ethical indefensibility. These concepts provide arguments in support of low rates of discount or non-discounting in forestry. On the other hand, financial returns in forestry are commonly low. There are high risks with investing in silvicultural activities due to long rotation ages, possible forest fires and so on, and due to frequently insecure property rights. Hence, decision-making on long-term investments in forestry practice, under risks and uncertainties, tend to encourage the employing a positive and even rather high value of discount rate, in order to ensure securing the benefits of timber extraction now rather than later (Samuelson, 1976).

The public forestry sector is usually able to allow for larger investments and for broader distribution of risk across risk-bearers. For that reason, the social rate of discount is usually lower than the private discount rate. Pertaining to the environment, a discount setting of 0-3% (Hanley and Spash, 1993) is most commonly chosen by governments for the forest policies world-wide. In private forestry, given the financial attractiveness of basic management and due to uncertainties, the choice of forest owner is in view of economics rather than in favour of the environment. Logic suggests that he limit the investment in incremental silviculture and keep the investment in growing trees until more can be earned by cutting the timber and investing the cash at the alternative rate of return, or discount rate. Consequently, forest corporations tend to employ basic management, which is based on quick replanting of desired tree species after harvesting. Thus the rate of interest plays an important role in economic calculations that determine decision-making in forestry. The discount rate is something we choose (Heal, 1981), and this choice, especially in public project appraisal, is partly a political issue.

During the transition period in the former command-and-control economies with the emergence of market relations governing timber production and trade, time preference is becoming an important factor in decision-making. Today, while the social rate of discount in forestry is officially kept at 0%, the rate of interest starts playing an important role in calculations that support decision-making at the level of forest enterprises. Risky investments in forestry-in-transition where the institutional environment is unstable and a high rate of interest evoke positive discount rates in financial calculation. This fact causes certain concern, because the use of a positive discount rate in commercial forestry will change forest management substantially. The results of calculations carried out for spruce provide evidence that using a positive discount rate of 4% and even 2% will greatly shorten the rotation period of timber

(Table 3.3). Using positive discount rate in Ukrainian forestry could jeopardise the valuable forest stands and enhance instead the creation of monoculture forest plantation. This practice will increase economic efficiency but will threaten sustainability and is especially dangerous for the mountainous forestry zone of the Carpathians. Currently, illegal timber harvesting is expanding in this area (Gensiruk, 1999).

Table 3.3 The Rotation Ages of Spruce in the Carpathians

Officially accepted	MSY, r=0%	Faustman, r=2%	Faustman, r=4%
81-100	70	36	32

Source: Data on prescribed rotation ages is that from the State Committee of Forestry (1998); the rest estimates are computed on basis of the data from the Committee.

The conclusion is that the choice of a discount rate is essential for formulating a harvest policy. In economic decision-making the future matters, and therefore, a positive discount rate has to be considered for the second group[21] of forests in the Ukraine. The discount setting of 4% is employed in the majority of calculations in this study, given also the programme of afforestation. However, the introduction of a positive discount rate in forestry practice has to be done in combination with consideration for environmental effects of forests (cf. Brukas, 2001). Under the present institutional setting, the imposition of a discount rate higher than 4% in commercial forestry decisions could threaten the environment. Risk is involved when the resources are undervalued, when rural amenities and environmental services are not remunerated and when positive externalities are not incorporated in the forest policy design.

A purely economic approach might be socially unacceptable for forestry-in-transition. Firstly, even under conditions of a properly functioning market, it is hardly possible to account for all social and environmental costs and benefits of production and to set prices to guide the use of resources in a sustainable way. In forestry-in-transition, neither prices nor rents are useful indicators of forests' sustainability. Secondly, in the Ukraine, the ideas of MSY and maximum increment of the most valuable assortments are deeply embedded in the way of thinking, and time is needed to realise the changes.

3.2.5. Sustainability criteria and indicators

Sustainable forestry means stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfill, now and in the future, relevant ecological, economic and social functions, at local, national and global levels, and that does not cause damage to other ecosystems (Helsinki, 1993). For the concept to become operational, it has to be defined by criteria. Generally accepted criteria of sustainability in forestry have been developed by a number of international organisations, such as the ITTO (1991), IUCN (1993), Canadian Council of Forest Ministers (1997), and a number of others. In the current study, I make an attempt to accommodate generally accepted criteria in the particular setting of the forestry-in-transition (Hardashuk and Nizhnik, 1995).

Sustainable development of Ukrainian forestry is seen in view of the advance of economic and institutional reforms towards a market economy. This will promote economic efficiency and welfare maximisation and will attend to balance economic, social and environmental components of sustainability, and within the forest economy,

[21] Forests of the second group are used for timber supply.

to balance the demand and supply sides of timber production. The suggested criteria of sustainability for Ukrainian forestry-in-transition are as follows:

- Economics of forest resources' use;
- Institutional framework in forestry.
- Productive capacity of forests;
- Contribution to global carbon cycle and climate stability
- Social functions of forest;
- Soil, water protection and regulatory forest functions;
- Health and vitality of forest ecosystems;
- Biological diversity.

Some of the criteria characterise economic development of forestry, the others are important under specific institutional setting, environmental conditions or with respect to ecological forest functions. The criteria that have not been addressed sufficiently for Ukrainian forestry[22] are explored in the subsequent chapters of the thesis.

Because of the non-internalised externalities and market imperfection, sustainability in forestry is to be assessed by using economic, social and physical (Kuik and Verbruggen, 1991) indicators. Working out sustainability indicators is an important task for forestry in many countries. The examples of most commonly used indicators are provided in Table 3.4.

Table 3.4. Examples of Sustainability Indicators in Forestry

Economic	Social[23]	Physical
prices of timber and non-timber products, investments, costs, benefits and NPV from the investments, producer and consumer surpluses, scarcity and quasi rents	welfare and health of rural communities, level of employment, recreational activity	wooded area, volume of standing timber, MAI, non-timber production, area of old-growth forest, strictly protected area, spread of erosion, area used for recreation and density of people, measures of biodiversity

The economic criterion of sustainability seems to be less defined in the literature and in the indicator systems currently being employed. Consider rents that are useful indicators of sustained timber management. Scarcity rent is a difference between marginal revenue and marginal production cost that can only come about as a result of the scarcity of the resource. Quasi rent accrues to a resource supplied out of human and human-made capital, and it is the difference between total revenue and total variable cost (Van Kooten, 1995). As a rule, rent is a measure of wealth. The proportion captured by government indicates whether or not government revenue from forestry is sustainable. Recording of rent capture provides an indicator of the sector's sustainability, because under the conditions of a market economy, rent capture accelerates technological development in forestry. The rent from timber harvesting incorporates technological advance that allows for more efficient production and rent accounts for changes in timber supply. All these measures are based on a rather stable market environment.

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[22] Forest ecology, productivity, health and vitality and biodiversity have received sufficient attention in the Ukraine The Ukraine's Laws (1995-2002), on: http://www.rada.gov.ua and http://www.rada.kiev.ua

[23] To limit the scope of the study, this block of indicators has not been paid enough attention to, but this is a challenge for the future research.

In the country-in-transition, the situation is different, and neither prices that under the conditions of economic instability are incapable of reflecting resource scarcity, nor dissipated rents, can serve this purpose. In an economy where forest resources are undervalued and the market does not function properly, rent-seekers tend to redistribute wealth according to their private interests by artificial manipulation of prices. These personal interests usually have nothing to do with more efficient use of the resources or technological innovation. The discrepancy between the prices of timber production in the Ukraine and the prices for timber on the world market allows the rent-seekers to sell timber abroad, to capture the rents and to accumulate the money in personal bank accounts.[24] Total losses to the state budget from illegal export of natural resources are substantial (Fonkych, 2000). In the way provided in Figure 3.4, rent seeking promotes illegal harvesting and exporting of timber, while neither prices nor rents are useful indicators of sustainability.

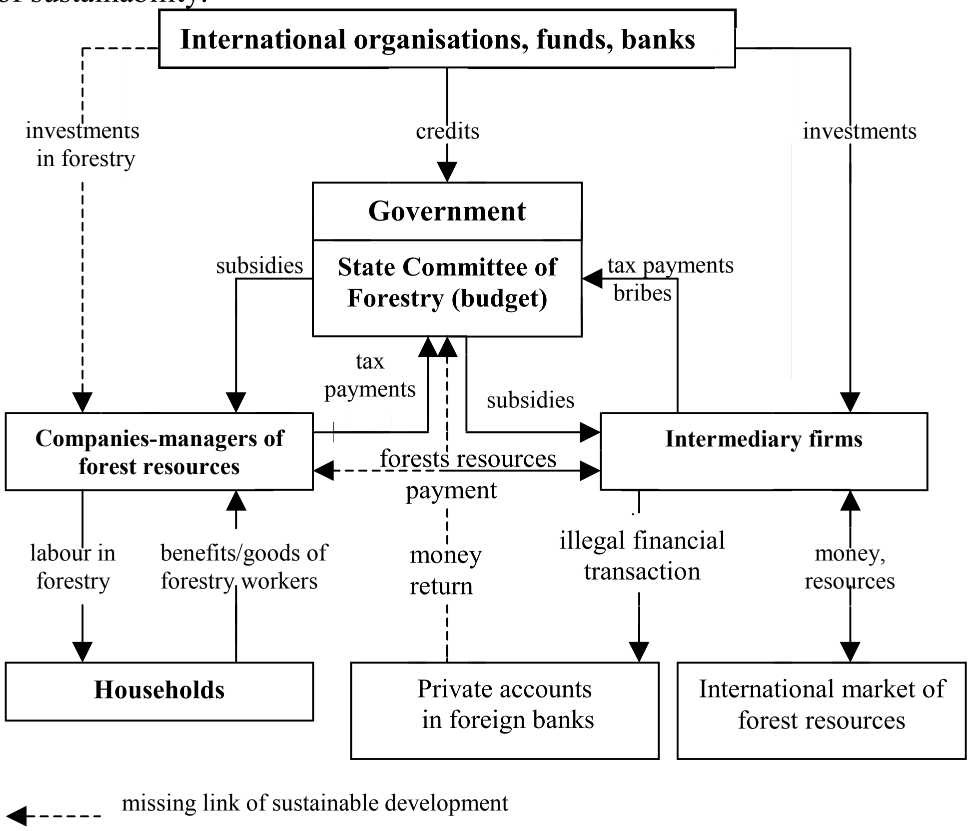

Figure 3.4. The Dissipation of Rent and Losses from Rent Seeking under conditions of Improper Institutions[25]
Source: Developed from Fonkych (2000)

The returns from this exporting of natural resources largely go to personal accounts of the accomplices of the shadow economy (Hryniv, 2001). The dissipated rents are used to bribe the policy-makers and government officials. Partly, they are invested in further development of intermediary firms. Over time, some of these firms simply disappear and some become a monopoly in trade that deals with the natural

[24] Recent legislative rules (2002) restrict export of timber: http://www.rada.gov.ua
[25] The arrow shown partly with a dash, and partly with a continuos line means that a part of the money comes from intermediary firms to the forest companies.

resources. Hence, while with proper institutions, exporting of timber will be beneficial for the forest economy because it can be used to shorten budget deficit and to modernise the machinery, in the country-in-transition, this is not the case. The phenomenon of "missing links" is indicated in Figure 3.4. Ukrainian economists argue that the losses to the national budget from these "missing links" that support the shadow economy of natural resource extraction/use and also shadow export operations are considerable (Hryniv, 2001). This discussion indicates that in a transition economy it is much more difficult to suggest economic indicators of sustainability than in a market economy, because the prices do not reflect the real value of the resources and their scarcity. Therefore, for the Ukrainian case, it is exceptionally important to use concurrent types of sustainability indicators: economic, social and physical.

The development of markets to internalise externalities and the role of institutions are essential in realising sustainable forestry development. In this sense sustainability is more than a scientific concept, being also a political concept that is supposed to be implemented practically. I consider sustainability as a goal and also as a strategy. Transition to sustainability means transition from the planned economy to a market economy. Sustainable development of the Ukraine's forest sector requires economic and institutional changes, changes in objectives, in legal and institutional frameworks and also in the attitudes of the actors towards the common interest of maximizing inter-temporal social welfare.

3.2.6. Sustainable forest policy

Economic, social and environmental components of sustainable forest policy incorporate a set of measures to direct the forest sector towards sustainability. For simplicity, it is assumed that policy measures answer the question: what has to be done? For instance, one of the proposed forest policy measures is economic substantiation of optimal harvest cycles. This measure is to decrease, in most cases, the ages of timber harvesting and is to balance demand and supply sides of timber production. An expansion of the forest area into waste and marginal agricultural lands is also put forward as a sustainable forest policy measure that will positively affect the resource base of the forest sector and will address environmental goals. The majority of the policy measures, provided in Table 3.5, are elaborated in separate chapters of the thesis.

Application of the policy measures presented in Table 3.5 requires policy instruments to be employed. Policy instruments answer the question: how the changes (policy measures) are to be implemented. Oskam et al. (1998) distinguish six main groups of instruments: regulation; information, persuasion and awareness; technological and institutional change; arrangements between governments and organisations; economic incentives; and private law instruments. There are other approaches to environmental policy in practice (Verbruggen, 1994) and to its certain aspects, such as the interaction between companies and the authorities (Woerd, van der, 1997).

The purpose of the current section is to present an initial scheme for sustainable forest policy implementation in the Ukraine rather than to discuss policy instruments in detail. Because of that, a number of questions put forward by Oskam et al. (1998) are not developed in this study. It is also omitted because, in economy-in-transition certain policy instruments, such as private law instruments or arrangements between governments and organisations, are not yet applicable.

Table 3.5. Policy Measures for Sustainable Forestry in the Ukraine

Economic	Social	Environmental
Focus on economic indicators of sustainability, e.g. prices, economic rents, costs and benefits. Economic substantiation of timber rotation ages (Chapter 3).	Focus on human dimensions and social indicators of sustainability, e.g. employment, welfare of rural communities (Chapter 4).	Focus on physical indicators, e.g. wooded area, standing stock, MAI, species composition, and health and vitality of forests (Chapter 2).
Institutional transformation, redefinition of property rights and development of private sector of the forest economy (Chapter 4).	Institutional transformation, changes of informal rules, attitudes of the policy actors, upgrading of social capital (Chapter 4).	Afforestation, reforestation and forest regeneration (Chapter 5).
Technological modernisation, rising economic efficiency in the forestry sector (Chapters 2 and 4).	Structural reorganisation with respect to demographic and social conditions, development of transport and social infrastructure in less advanced regions.	Development of recycling, material saving and cleaner technologies, LCP[26], alternative sources of energy and waste utilization.
Extension of regional economic relations and international co-operation, development of joint projects.	Creation of new working places, enhancing of social security and human dimensions in forestry.	Co-integration the economy and the environment, multi-functional use of forests, environmental focus toward rural development (Chapters 2 and 5).
Demonopolisation, structural reconstruction and functional differentiation of the sector (Chapter 2).	Extension of information and education, including distance education in forestry/management.	Extension of the network of natural reserves, creation of the joint system of natural protected areas.

In view of the approaches to sustainable development mentioned above and on the basis of the classification used in the Netherlands Environmental Plan (VROM, 1993), three major sets of policy instruments: economic-financial, regulatory and informative are proposed for the forest policy in the Ukraine:

- Economic instruments applicable for the policy of sustainable resource use and the environment under conditions of a market economy are analysed by Baumol and Oates (1975). Pettenella (2001) considers them for forestry-in-transition. In Ukrainian forest policy, main economic instrument is a subsidy. The level of the pollution charges is usually set too low to serve a feasible incentive to prevent the pollution. The stumpage fees do not provide the enterprise with economic incentive. An important task is to make economic instruments workable and to broaden their scope. Economic instruments are (1) to bring opportunity cost principles and (2) to internalise externalities by improving the system of payments for natural resources' use and environmental pollution. Economic policy instruments are to presume profit

[26] Life-cycle production.

and demand oriented timber production and privileged conditions for silvicultural investments, including foreign.

- Regulatory instruments comprise scientifically substantiated system of norms, rules and permits. The norms of annual allowable cut in the Ukraine's forest sector have to be adjusted. It is so, because for many years, harvesting that could be sustained forever was regarded as the best option. Consequently, today, official timber cut in the Ukraine comprises less than half of MAI, while in stable economic conditions the country has good opportunities for wood-processing and timber use.
- Information, as a productive force that encourages cost-efficiency and enhances environmental standards, is becoming a prerequisite for sustainable forestry development. The rising demands for economic and social forest functions require additional information. The process of globalisation makes the role of means of communication important (c f. Nijnik and Melnik, 1999). Therefore, to meet present-day requirements of the forestry sector, it is acute to develop computerized informational system that will provide sufficient and relevant information to the stakeholders, and top-down, to a single production unit. Concurrently, the system will enable the Ukraine to offer necessary data to the world community for the development of the European common policy of sustainable use of forests. In view of that, reliability and authenticity of information become very important.

Important tasks are to choose proper policy measure to focus on each objective (target) of the forest policy and to elaborate policy instruments that will ensure its most effective, efficient, legitimate and feasible implementation. To develop a complete set of the proper combination of policy measures and instruments for a transition economy, as was done by Oskam et al. (1998) for a market economy, is not possible within the capacity of this study. Therefore, I adjust the ideas for a particular case of Ukrainian forestry-in-transition. In Figure 3.5, I explain briefly which instruments are most appropriate for certain policy measures. The perceptions presented in the figure are largely adapted from Krott et al. (2000) who have done quite some work in this direction and with particular interest to forestry in the Ukraine. Certain elements of Figure 3.5 are developed in the subsequent chapters of this thesis.

Current separation of forest enterprises from timber harvesting and the separation of timber production from financial flows limit effectiveness of economic policy instruments (Krott et al, 2000). Closed production lines (Figure 3.5) within the forestry enterprises that start from silvicultural activities, such as tree-planting and thinning operations, and end with timber harvesting and forest renewal will be much more beneficial for implementing sustainable forest management. Today, however, having no incentives for the creation of valuable stands, forest enterprises intend to substitute final harvesting with thinning and to gain profits through thinning operations, violating the forest policy rules and leading to unsustainability in the sector (Krott et al, 2000). Cost-benefit analysis of managerial decisions, and demand and profit orientation of timber production, are necessary requirements for transition to sustainable forestry. Then, there will be no acute necessity in high state investments in silviculture, and forest renewal will become a reasonable goal for each closed forest enterprise. Profit orientation in the sector will decrease the necessity for subsidizing heavily timber production, and forestry will better address market demands and environmental requirements.

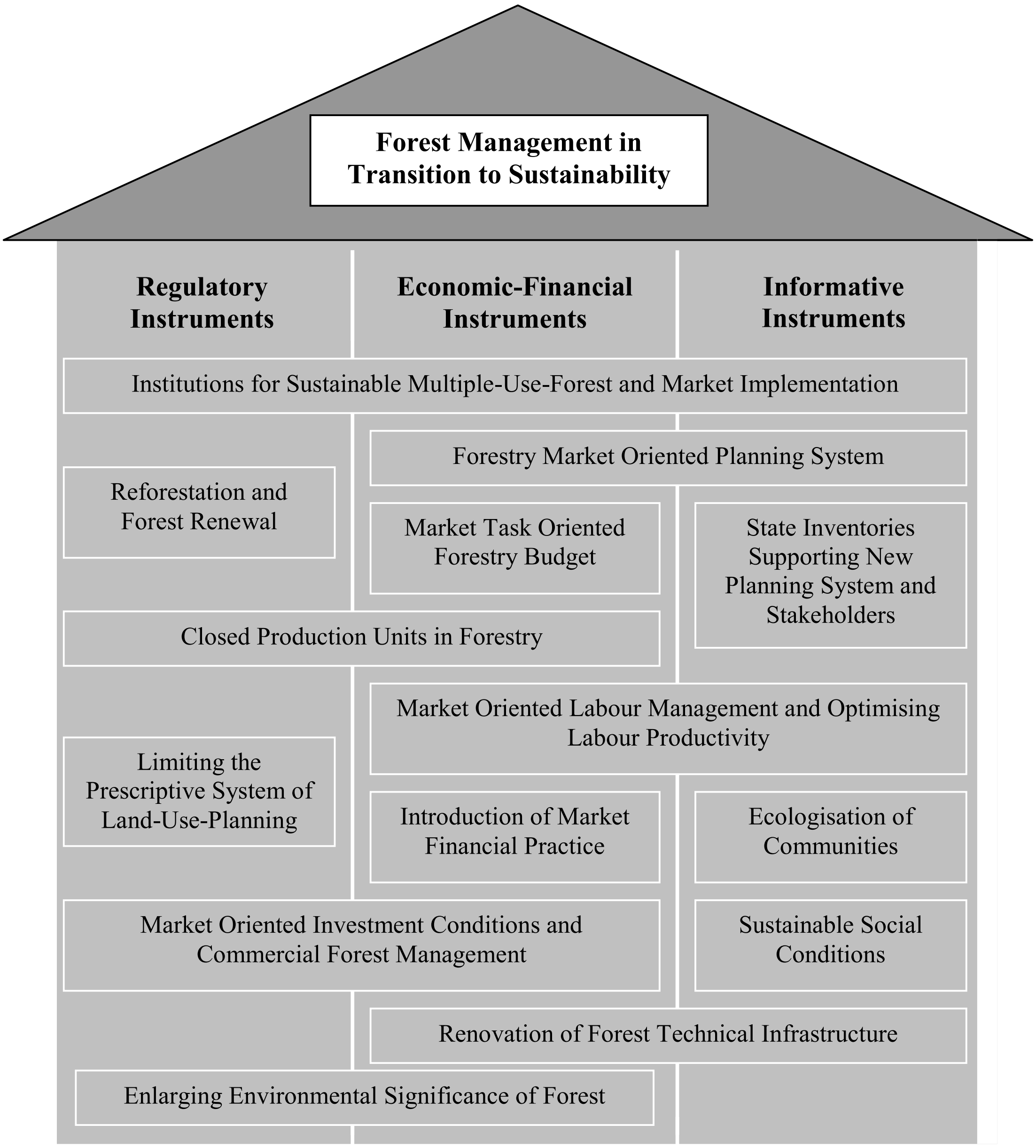

Figure 3.5. Forest Management in Transition to Sustainability
Source: Developed on basis of Krott, M. et al. (2000)

To ensure sustainable multi-functional development of the forest sector, the economic forest policy reform focused on enlarging efficiency in timber supply should be complemented with well-targeted measures to preserve forests and to conserve their biodiversity and landscape values. Since forestry-in-transition is faced with acute market failures, improper institutions and rent seeking, governmental intervention in terms of public environmental and social policies is justified. Thus during the transition, administrative regulatory forest policy instruments will remain strong. However, main focus should shift to the development of economic-financial incentives of sustainable use of forests and to the advance of informative forest policy instruments.

3.3. Conclusions

Sustainable forestry is a component of sustainable development of the economy. Economic sustainability in forestry, however, has not been paid attention in the Ukraine, because an ecological approach to sustainable forestry and the ideas that relate sustainability to the resilience of forest ecosystems have received strong support within the National Academy of Sciences and since 1970s, among official policy-makers. The ecological concept of sustainability that governs in forestry negatively affects the performance of the forest economy. During transition to a market economy, economic analysis is becoming an important element in decision-making in the forest sector and on the level of forest enterprises. High interest rates and comparatively low costs of timber harvesting per unit of effort provide forest practitioners with incentives to encourage harvesting. Thus there is a contradiction between the forest policy and practice, and the ecologist's attitude on sustainability in forestry has to be changed. A sustainability concept that is to be introduced in forestry has to be based on the idea of weak sustainability and has to incorporate first of all economic dimensions.

An economic perception suggests that sustainable forestry in the economy-in-transition to a market economy can exist only if the returns to it exceed those of alternative uses of the land and exceed the costs of forest management. In such a way, sustainable forest management is embodied in practice of sustained timber management. However, the Ukraine inherited from the previous political and economic systems mechanisms of decision-making that are not adjusted to the present and future conditions for wood production and consumption. Adequate financial and capital inputs are not available. Thus the changes have to be introduced into the forest sector to address sustainability economically. Sustainable forest policy measures and instruments that are proposed in this chapter and developed further in the thesis are focused on the enhancement of economic and environmental role of forests and the improvement of the country's forest resources potential. To enlarge the efficiency of timber production, with perspectives for the Ukraine to become an exporter rather than an importer of timber (the idea supported by Nilsson and Shvidenko, 1999), it is suggested to substantiate according to economic requirements timber rotation ages in commercial forests. Afforestation of waste and marginal agricultural lands is elaborated as another major complementary measure of sustainable forest policy.

It is not possible, however, to make the economic concept of weak sustainability operational, under conditions of inadequate institutions and acute market failures, when forestry is a monopoly of the state, property rights are not guaranteed, labour and capital markets are meagre, information for producers and consumers is incomplete, and forest resources are undervalued. The conclusion is that, under conditions of market failures and improper institutions, which are typical for transitional economies but also hold for external effects in every economy, the economic concept of sustainability is to be supported by social and environmental components, and sustainability has to be measured concurrently in economic, social and physical terms.[27] The way to sustainability in forestry lies through the development of markets, internalising the most important externalities and changing institutions.

[27] Of course, that still brings up the question how to balance these different aspects.

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4. TO SUSTAINABILITY BY CHANGING INSTITUTIONS[28]

In this chapter, I address governance in Ukrainian forestry by analysing the institutions and investigating their impacts on economic and environmental performances. The research questions are: how does the transition to a market affect the forest institutions and what are the trends, impacts and remedies for promoting sustainable forestry? The combination of past exploitation of forest resources with the slow pace of economic and political reforms is a major obstacle to implementing sustainable forest policy decisions. The way towards sustainability goes through changing institutions. The human dimension of institutional changes investigated in this chapter plays an important role in the process of transition. The chapter draws on the state of affairs in forestry with failures and new incentives for economic and institutional reforms.

4.1. Introduction

The future of the economic and social development of a country in transition substantially depend on institutional transformation, and the changes that are taking place have contributed to focusing new attention on the role of institutions and organisations in the transitional process. For the Ukraine, institutional transformation is seen as a way to build a democratic society and to bring economic reforms, to favour the forest sector of the national economy with economic incentives and appropriate policies and to improve its economic and environmental performances.

The objective of this chapter is to consider institutional transformation in the forest sector of the national economy. The chapter provides the analyses of the existing institutions and organisations and derives directions of institutional changes for enhancing sustainability in the Ukraine's forest sector. The study deals with changes in the institutional environment, encompassing both formal and various informal rules. It also focuses on the transition of the institutional arrangements. Institutional transformation in forestry is addressed as a comprehensive system of new rules and organisations that is to be placed under the obligation to turn the forest sector towards sustainability in conditions of a market economy.

There are two main methodological approaches to investigate institutional changes (Ostrom, 1990; North, 1993; Sabatier, 1998;). The first approach focuses on the role of the involved actors and considers action in their field. The Institutional Analysis and Development Framework (IADF) considers a minimal action situation, where actors have their preferences, information-processing capabilities and selection criteria (Ivanova and Nygaard, 1999). Substantial changes in the action arena have to be made to enhance economic development. Both the attributes of the physical world (cf. Nijnik and Van Kooten, 2000) and the rules in use that constitute the institutional environment and attributes of the community have to be modified (Ostrom, 1994).

There are two ways of exploring the mechanisms of institutional changes from the actors' perspective (Weimer, 1995). One way is to consider changes as caused by the protagonists' response to shifts in relative prices and preferences. This approach argues that inefficient institutional arrangements could exist because of path dependency when it is too expensive to change organisations but new institutional arrangements that

[28] The chapter is originally written as a stand-alone paper "Governance in Ukrainian Forestry: Trends, Impacts and Remedies" (co-author A. Oskam) submitted for publication to Agricultural Resources, Governance and Ecology (2001).

enhance economic growth are continually created in the society (North, 1991). Another view within the actors' scheme explains institutional transformation as a result of conflicting interests, when institutional arrangements change because of bargaining and thus changes are not always progressive (Knight, 1992).

The second way to address institutional transformation is to focus on economic development and to consider endogenous the system of institutions that depends on the level of economic advance. At certain stages of societal development, economic development exceeds the pace of institutional development. When this gap appears to be too broad, political and social preconditions for institutional transformation arise within the society itself. Organisation and actors' perceptions are regarded as important, though they are not considered the main cause of institutional changes but rather their consequence. The idea is relevant for a command-and-control economy, where the role of actors was not crucial, while the economy was considered as a basis for the progress of the society.

The situation with the collapse of the command-and-control system can not be purely incorporated into any of the theoretical schemes I have just discussed. It was likely the case that the actors themselves have realised political changes. Thus initially the changes probably occurred according to Knight's theory. They favoured those with advantageous bargaining power, and that could be among the reasons for the poor performance of the transitional economies. The purpose of the study is to review the current state of institutions in Ukrainian forestry and to consider their future development, which in turn depends on the forest policy which the country adopts.

We begin in Section 4.2 by discussing the institutional environment in the Ukraine's forestry. The institutional environment comprises formal and informal rules that will be investigated. Then, we examine the institutional arrangements, the play of the game (North, 1993). Considering institutional arrangements, special attention is being given to government failure and to market failure in the forest sector, which hamper its progress towards sustainability. There are three basic problems while changing the rules of the game (Carlsson and Olsson, 1999), which we consider as valid for the institutional transformation in the Ukraine. First, there is the legacy of history, i.e. for any new order of things policy makers have to prove that this order is better and more effective than the old one. The second problem is that knowledge and skills reside in people and that "organisational renewal is a more complicated process than just reorganising or instituting new units and agencies". In order to change the state of affairs special competence from the authorities is therefore needed. The third issue is the role of the individual and his ability to change his behaviour, norms and attitudes, because "institutional changes go along with changes of the individual and versa".

These basic problems of changing the rules of the game are analysed in Section 4.3, which focuses on social capital in the forest sector, on knowledge and skills in people and on the role of individuals in the institutional transformation. Advanced silviculture and education are the endowments that the Ukraine possesses to successfully develop its forestry towards sustainability (Gensiruk et al., 1995). However, to switch on to a sustainable path, forestry has to have - together with advanced science and education - properly established informal rules and competencies. They are reflected in public opinion, namely in the attitudes of forest managers to the process of institutional changes. Attitudinal diversity of forestry actors towards sustainability and a market economy is identified and explained by using a Q-methodology research tool. The Q-analysis enabled us to conclude that for successful transition of the forest sector towards sustainable development within a market economy it is important to enhance the changes in the action arena, "moving away from old sets of norms, rules and mental models" (Benham, 1995). The section concludes with the framework of institutional transformation proposed for the Ukraine's forest sector.

Then, in Section 4.4 we identify key directions in changing the rules of the game and the road that future forest policy needs to take. Transformation of the institutional environment and institutional arrangements, entailing a shift in the attitudes of the policy and management actors and their acceptance of market relations, are crucial for the transitional process. To make the changes radical, not incremental, all actors involved in the process of institutional transformation have to acknowledge that there will be no sustainable forestry without recognition of market changes. Privatisation, stabilisation and liberalisation are essential components of the transition. To put forest management on its sustainable path and to develop a highly productive wood-processing sector, the country needs to shift all building blocks of institutions towards market changes.

The research methods focus on documentation of the institutional environment and institutional arrangements, on the developed framework of institutional transformation and on interviewing the forest policy actors. A Q-methodology approach is applied as the main tool to study attitudinal diversity of forest policy actors concerning market changes and sustainability in forestry. The conclusions ensue.

4.2. Rules in Use: Do They Work for Sustainability?

4.2.1. Institutional environment: political and economic rules

Following actors' perspectives of exploring institutional changes in the Ukraine's forestry, we consider that institutions represent themselves through a legal relationship between economic actors, and that the rules in use, both formal and informal, are forces that govern the patterns of interaction among various actors within the institutional system (c f. Ostrom, 1994). The Ukraine had no market tradition for almost a century and with the collapse of the communist regime, the stock of institutions in the country has changed at a margin. Sequencing of the institutional environment is therefore a priority for the Ukraine, together with proper timing of the reforms (Schrieder, 2000). Currently, the institutional environment is not ready for rapid market changes, and the transition is likely to take decades (cf. Eggertsson, 1994).

During transitional period, the relation between state and economy remains very important in the society, and its further development involves first of all a redesign of the institutional environment and of the framework of what was once a centrally planned economy (Raisser, 1997). The role of the state in the Ukraine is therefore to create and to enforce "rules of the game". Only if the state commits itself to rules and norms of behaviour, will the process from totalitarian over-regulation (Soviet type economies), through dysfunctional ad hoc arrangements, and inefficient selective intervention (typical for transition economies), to a stable self-regulating new system be successful (Hohmann, 1999). Thus for the Ukraine, and for its forest sector, progressive changes in the institutional environment, in formal and informal rules, are crucial.

Currently, because of hierarchy in governing the institutional environment in the forest sector comprises mainly government laws and regulations. It is necessary that the state, in these conditions, plays an active and formative role in the creation of new rules to overcome the legacy from socialism (Schrieder, 2000). However, there is now no emphasis on property rights in the Ukraine's forestry legal documents, nor any visible relations between prevailing institutions and contracts/markets, also in the main forest law. The Forest Code (1994) formulates regulatory rules of forest management towards sustainable use of forests in the national interest. However, the legislation stipulates that forests have primarily water-conserving, soil protective, air-cleaning and health-giving functions, their economic use having a limited importance (Andrusyshin, 1994). The directions of forest management stated by the Forest Code are: increase of forest covered area up to the optimum for every natural zone; conservation of biological diversity of forest ecosystems; increase of forest ecosystems resistance to negative environmental factors, climate change and anthropogenic factors; rational, inexhaustible use of forest in order to satisfy demands in timber and wood products; amelioration and forest cultivation in the Steppe (Samoplavsky, 1997).

Other laws related to forest management include the Land Code (1992), On the Conservation and Development of Areas of Natural Reserves (1992), On the Permits and Limits of Natural Resources' Use (1992), The System of Payments for Natural Resources Use and Environmental Pollution (1992), On the Protection and Rational Use of the World of Plants (1999) and On the Protection and Rational Use of the Animals' World (2002), On the Red Book of the Ukraine (2002) (The Ukraine's Laws, 2002). Due to high transaction costs, the laws remain sometimes "paper laws".

Also, though the legal system regarding forestry has already been established, legislative norms and rules do not correspond to the idea of market changes. As a result of concern caused by the environmental situation in the country, in all these legislative documents, forests' shelter functions have received special attention, while economic reforms are not the main focus. The most important for forestry-in-transition economic role of forests, with a clear definition and insurance of both property rights and market liberalisation in forestry, have not been resolved. The environmental lobby impedes structural institutional changes by actively opposing the idea of incorporating market dimensions in forest policies. The law "On the Moratorium on Clearcuts in the Mountainous Slopes of Spruce-Beech Forests in the Carpathians" (2000) is further evidence of environmental priorities within the forest policy, and of an attempt to apply administrative command-and-control instruments to forest management.

Furthermore, the Ukraine's forest policy documents "lack specificity in administrative and fiscal processes and leave many interested parties with control over forest resources without properly defining their responsibilities" (cf. Nilsson and Shvidenko, 1998). The legislation is often misleading and contradictory. The Forest Code conflicts with the Constitution on property rights issues concerning the question of forest privatisation. Often, there is lack of synergy between legislative rules, so that there are two parallel processes "where parliament adopts its laws in the form of resolutions, and the President does likewise in the form of presidential decrees"(OECD, 1997). Also, regulations regarding e.g. the tax system and price-forming policy are changing rapidly, and enterprises are often unable to follow them. The prices on forest products were fixed at a low level until 1991, mostly by a central authority. Price liberalisation with subsequent high inflation affected the forest sector and frequent reactive changes in the price-forming policy attempted to restrain a consequent rise in prices. Frequently changing regulations, their contradiction and verbosity make management rules hard to implement practically and they remain open to arbitrary decisions as well as provoking corruption.

Corruption in the form of patrimonialism is among the main problems that substantially hamper the process of transition in the Ukraine. Patrimonialism is when the state or her politicians considers herself the ruler and the proprietor of the country. The phenomenon unites together the economy and politics (Jensen, 1997) and brings in politonomy. "No institutional or ethical border separates statesmen and businessmen in Ukraine. State is often (mis)used to strengthen the individual position of a politician, his industry's or his region's financial position. Careers are made across government, enterprises and lobbying groups" (Von Hirschhausen, 1998). The most destructive phenomenon that is observed in the Ukraine is the "criminal-political nexus, the alliance among former Party elite (communist), members of the law enforcement and security apparatuses, and gangs of organised criminals". These phenomena in governing have resulted in the Ukraine's situation: that the "privatisation programme was undermined by former Party officials and a criminal elite, who appropriated state resources by stripping assets from banks and enterprises" (Shelley, 2000). The processes are observed despite an anti-corruption law (1995) and a national anti-crime programme (1996).

Table 4.1. "Unofficial" Payments by Enterprises for Official Permits

"Unofficial fee": type of license/ favour	Average "unofficial" fee, required for "favour", USD*		Share of enterprises admitting to pay "unofficially", %	
	1996	1994	1996	1994
1. Enterprise registration	176	186	66	64
2. Each visit by fire/health inspector	42	40	81	72
3. Tax inspector (each regular visit)	87	91	51	56
4. Each phone installation	894	550	78	95
5. Lease in state space (m^2 / month)	7	(n.a)	66	88
6. Each export license/registration	123	217	61	96
7. Each import license/registration	278	108	71	93
8. Each border crossing (lumpsum)	211	194	100	90
9. Each border crossing (% of value)	3%	(n.a)	57	(n.a)
10. Domestic currency loan from bank (preferential terms)	4%	(n.a)	81	(n.a)
11. Hard currency loan (prefer.terms)	4%	(n.a)	85	(n.a)

Source: Raiser (1997).

*- Average among those that admit making unofficial payments. Data is based on survey of 150 state and private enterprises in five large cities of the Ukraine.

The officials in the Ukraine are poorly paid and take advantage of their positions. Continuity in governing is characterised by the support of high taxes among the officials, who oppose tax cuts "for fear that they will tempt many private firms out of the shadow economy, thus eliminating lucrative corruption-related opportunities for themselves" (Shelley, 2000). The existing system of taxes creates strong incentives for enterprises to pay off officials rather than pay those taxes, and negotiations and agreements between managers and authorities, even edging over into cheating become necessary for business survival (Raiser, 1997). Table 4.1 shows that business is paying significant amounts in bribes to avoid inefficiency or intends to submerge its operations. "Violation of the rules is often profitable as the possibility of being caught is low, punishment is no deterrent, and one can usually bribe one's way out of a situation" (Ivanova and Nygaard, 1999). Thus, half of the enterprises regularly pay an unofficial fee to tax inspectors (Kaufmann, 1998), and almost two-thirds of the managers regard corruption as a major problem that business has to face (Shelley, 2000).

Average levels of unofficial fees and the proportion of enterprises that pay, indicate the difficulties which entrepreneurs have to overcome in order to establish a private firm, to receive a bank loan, or to initiate export and import operations. Consequently, unofficial economy in the Ukraine has increased considerably, and in 1998, 70% of enterprises operated in the "shadow", providing about 50% of the GDP (Shelley, 2000). Unofficial business reduces the tax base of the State and official foreign exchange holdings and worsens an overall economic performance. Though we do not have data on business underground in the forest sector, the situation is likely to be especially bad in the sectors of the national economy that are coping with extraction of natural resources. In this respect, we can only add that illegal timber harvesting in the Carpathians recently expanded enormously (Gensiruk, 1999), reflecting the continuity of governing in the Ukraine's forestry and general difficulty with which the process of transition to a market economy in the forest sector is proceeding.

4.2.2. Continuity of governing

Continuity of institutional arrangements in the Ukraine's forestry is even better observed than that of the institutional environment. Governing in a transitional economy entails four major institutional strategies: democratisation and participation; economic liberalisation and privatisation; political, administrative and fiscal decentralisation; and restructuring government (Gerrard, 2000).

The institutional arrangements in the Ukraine's forestry are characterised by co-management arrangements among the four major forest policy actors - central government agencies, local governments, community-based organisations and enterprises, including privatised wood-processing units. At this time, however, the state through its politicians remains the main policy-maker and the dominant and privileged principal in the Ukraine's forestry. The Parliament, the central legal body, and the State Committee of Forestry, the Ministry of Ecology and Natural Resources, the forest user and the co-ordinator of forest policy implementation, are the main actors involved in the forest sector's institutional framework. Implementation of the forest policy is carried out by forest enterprises and by user groups from local communities that directly interact with forests. Task division between various managerial structures is not legislatively defined and their institutional consolidation is thus not properly ensured. The role of scientists, educators and public organisations is minimal. Public opinion hardly influences policy decisions and it is not able to promote sustainable development as forest policy (Hardashuk and Nizhnik, 1995). Democratisation and participation in the forestry sector therefore do not occur.

There are three basic mechanisms of governance in the economies: markets, hierarchy (authority), and collective action. Markets constitute governance by voluntary exchange between two parties. Hierarchy is governance by command-and-control, when authority is assigned from one to many actors, top-down. Collective action is a co-ordination by common interest, when people act together (Gerrard, 2000). Prevailing institutions in the Ukraine officially constitute the authority of the hierarchy, when rules of governance correspond to government laws, and organisations are based mainly on governmental structure, while the whole system of institutions does not maximise gains for the participants. Markets, which are almost missing in the forest sector, provide scarce information about quantities and qualities of goods and services. This increases the costs of bargaining and of enforcing property rights leading to uncertainties in making, monitoring and enforcing contracts. Usually, the contracts, laws and conventions of a society (its institutions) either evolve to reduce transaction costs or fail to do this (Hubbard, 1995). Markets in the Ukraine's forestry are meagre, because their emergence has been blocked by the former system through decades.

The organisational form of governance in the Ukraine, a hierarchy (authority), was appropriate for extensive growth. Today, it is not workable due to cumulative effects of the system's agency problems and changes in the economy causing an increase in transaction costs. The changes identified by North (1997) include (1) a change in the productive potential of a society, which is a consequence of (2) a basic change in the stock of knowledge and which entails (3) an equally basic change in organisation to realise that productive potential. During these societal changes in the Ukraine old institutions become dysfunctional, but they tend to persist.

Following North (1991), the key reason for that lies in path dependency, in which institutions are self-perpetuating until trends of change in relative prices so increase the costs of maintaining existing institutions that pressure for reallocation of resources becomes irresistible. There is also a Prisoner's Dilemma explanation of the difficulties with the imposition of new institutions, showing that the costs of breaking rules are too high on individuals, and the imperfect information paradigm, which is based on uncertainty in the distribution of future gains from institutional changes. Market and democracy can therefore be established in the Ukraine only when it becomes feasible to "anchor them in the culture, history and traditions of the country" (cf. Hohmann, 1999 and Schrieder, 2000). New institutions have to adjust gradually to the stock of productive resources and to the stock of the existing institutions (Eggertsson, 1994). This is one of the reasons, why the second major institutional strategy in transitional economy i.e. economic liberalisation and privatisation also falters.

Organisations based on authority in the Ukraine's forestry further do not address the officially proclaimed policy of economic liberalisation and privatisation because of the informal rules within its institutional environment. Among plausible main coalitions in the Ukraine’s Parliament, i.e. democrats, communists and the union of "parties of the power” with the corresponding lobbies in forestry, only the democrats appear to pursue a strategy of open market changes.[29] The communists oppose privatisation for political reasons that are based on the idea of common property rights. The "parties of the power" union, which supports the current administration, has instituted a legacy of corrupted bureaucrats among the politicians ("The Day", 2001, Ukrainian Political Thought Journal, 2001 and Carnegie Endowment, 2001), is also not in favour of open privatisation. Specifically, they oppose diversified mass privatisation, because they could lose their power to distribute the natural resources according to their wishes, and they are not willing to share either their current notional rights to the resources or their current "profits" with private owners and western investors (Financial Times, 2001). They oppose the creation of an open market economy of a European style. The environmentalists, who recently dissolved among other political factions, also oppose

[29] The current composition of groups and fractions in the Parliament is as follows: the so-called "party of power" (United Ukraine - 178 and Social Democrats - 31); the democrats (Our Ukraine - 119; the Motherland - 23; Socialist Party - 21); Communist Party – 64 members; independent - 11 (http://www.rada.gov.ua).

market changes in the sectors of the economy related to the extraction of natural resources, because they are concerned that the resources would be "mined" and sold out by private owners. The transformation of political and economic institutions in the Ukraine therefore proceeds with extreme difficulty.

Government failure in the Ukraine could be examined on the basis of three theoretical models of the government (Shleifer and Vishny, 1998) called the helping hand, the invisible hand and the grabbing hand models. Good institutions are instrumental to positive economic development. Bad institutions retard economic growth. Government within a grabbing hand model is not oriented on efficiency, but rather on redistribution, and the institutional incentive to address economic efficiency is displaced by the idea of wealth redistribution for personal gain. Politicians and bureaucrats, focusing on their own objectives and on their desire to stay in power, follow their impulse to redirect wealth and the resources to themselves. Their actions substantially retard economic growth, leading to social distortions, corruption and poverty, restricting political and economic freedom (cf. *The Economist* 1999a),

Certain steps regarding decentralisation and restructuring of governing in the Ukraine's forestry have been undertaken, and structural reorganisation of the forest sector has taken place. The politicians substantiated the necessity of reorganisation by explaining that big wood-processing units could hardly be functioning efficiently within forestry enterprises in sparsely wooded countries such as the Ukraine. Differences between wood-processing, silvicultural, and timber harvesting activities and their production assets were given as major reasons for restructuring. The prevailing argument is that if wood-processing units are incorporated in forest enterprises, the sectoral principle of control over wood production becomes insufficient and levels of concentration and specialisation in the production stay low, thus efficiency decreases. Forest and wood-processing activities taken together increase the likelihood of inefficient division of labour and of the use of inappropriate technologies. This likely results in lower levels of professional specialisation and decreases labour productivity. Another argument was that the shortage of wood to satisfy the demands of wood-processing made preconditions for the violation of the regime of harvesting, and forests were threatened with overcutting. This political reasoning led to forestry and the forest (wood products) industry being split into two distinct bodies in 1996.

The State Committee of Forestry, which replaced the Ministry of Forestry and the Ministry of Wood-Processing Industry (Gensiruk eds., 1999) is currently a managerial body of the Ukrainian Forest Fund. The state forest resources are managed by the sole agency that ensures regeneration and improvement of the forest stock. Figure 4.1 shows that either the State Forestry Union or the Forestry Board exists in every administrative area of the country, and these are the main agencies responsible for the forest within the administrative areas. The newly established governmental structure of forest management also includes a network of educational institutions and research centres, special forest protection units and two National Natural Parks.

At a lower level of hierarchy within the system of state forest management, there are state forest enterprises and their functions include tree-growing activity and timber supply. The list of activities of the state forest enterprises differs substantially across regions, and in low forested areas they focus, in the majority of cases, just on silvicultural operations (Krott et al., 2000). State forestry enterprises comprise under their managerial structure numerous production units, forestries, wood-processing sectors and other enterprises that manage silviculture and timber supply (Figure 4.1).

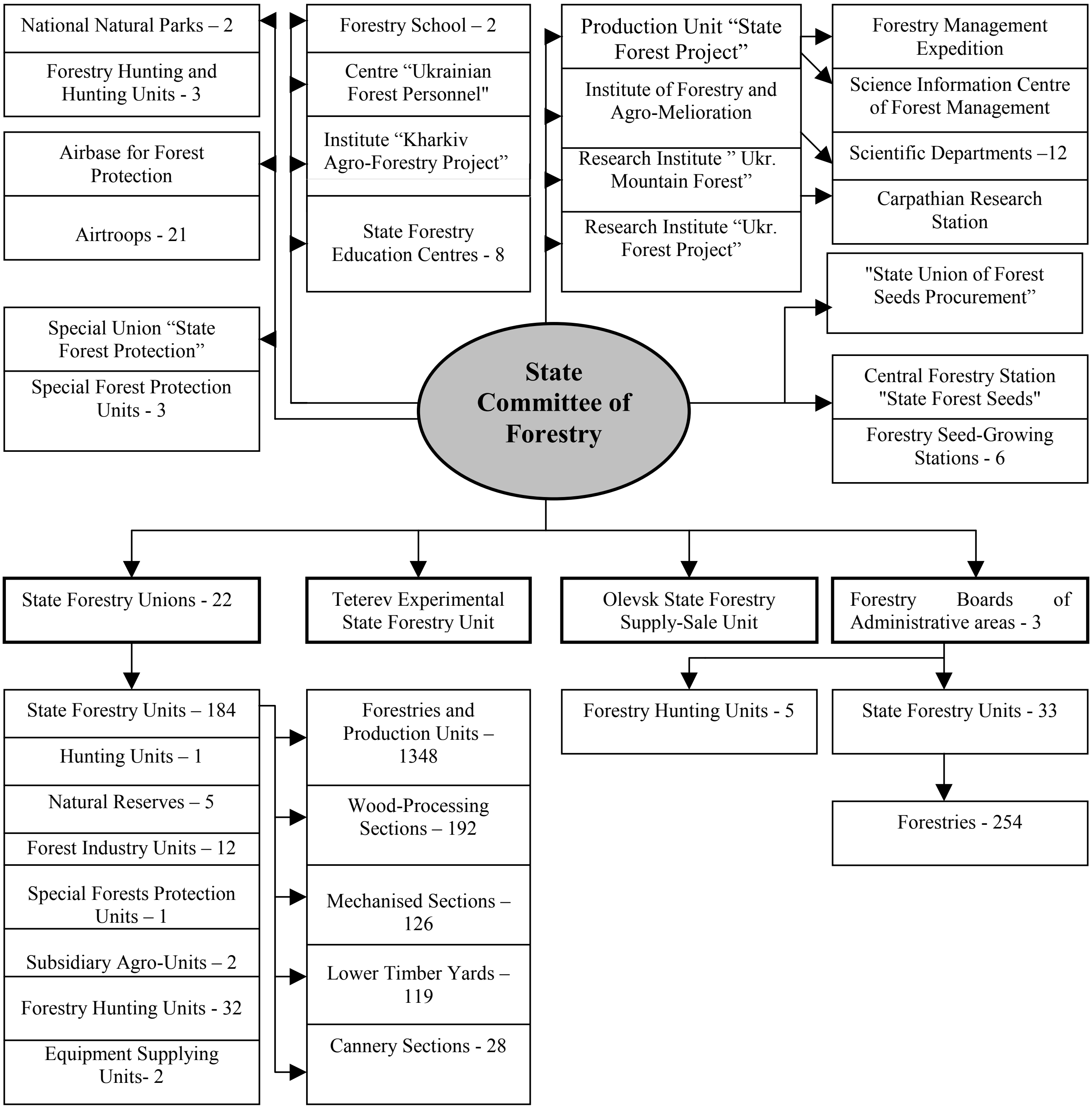

Figure 4.1. Governmental Structure of Forest Management
Source: State Committee of Forestry (1998)

The governmental structure of forest management also includes 41 hunting enterprises, 5 natural reserves and the supporting sections. It was expected that a newly established structure of forest management would be beneficial for forestry. Structural reorganisation as a political shift towards forest regeneration, afforestation and rising qualitative characteristics of forest stands was a positive phenomenon, under environmental reasoning. We think, however, that these changes, considerably further weaken the economic role of forests, all the more so after the State Committee of

Forestry was incorporated into the Ministry of the Environment and Natural Resources (Presidential Laws, 1999 and 2000). Officially, the Ukraine's forests are increasingly becoming conserved amenities, rather than resources of timber for the economy. Forestry depends on direct state investments and, when they are in short supply, it turns to the underground economy. If silviculture and wood-processing were placed together within properly established vertical integration instead, the industry would give economic incentives and economically support forestry, which now is hardly able to survive solely on the state budget (Krott et al., 2000).

Furthermore, structural reorganisation has caused distortions in practical aspects of the forestry sector because it has enhanced improper distribution of the machinery between the forestry and wood-processing sectors. As interviews with the forest managers have shown, this is an acute problem for forestry. In the absence of a market, it has also led to shortages of the equipment for logging and for transporting wood, and has resulted in decreasing productivity, in losses of timber and in its illegal selling out of felling sites (Olijnyk, 2000). This problem can be solved with economic liberalisation, with the introduction of market relations in forestry and with further development in the market of wood-processing technology.

A positive feature of recent reorganisation in the forestry sector was therefore a certain reduction of bureaucracy and non-productive costs. Governance structures did, however, spread out using command-and-control instruments rather than market incentives for sustainable forest management, and that threatens the forest economy. Additionally, control bodies have got lower expectations on enhancing proper utilisation of forests, the forestry agencies have become less able to perform their functions regarding resources allocation, and the enterprises have frequently become unable to function properly. Changing the governance, but keeping it a hierarchy without introduction of a market mechanism of governance with economic incentives, thus causes the forest policy to fail.

4.2.3. Forest policy and market failure

Economic liberalisation and privatisation should become strategic priorities of the institutional changes. The Ukraine's forests are, however, still owned by the State. The forest enterprises have the right to permanent use of forests, but privatisation and redefinition of property rights concerning forest resources and land are not established. The forest enterprises are not privatised and there is a monopoly held by the State. The main work in planting and in the protection of forests is still financed by the government, and statutory prices for standing timber are fixed. Thus, it is too early to analyse the impact of transition and the structure of property rights within the forest sector. According to the existing legislation, an overall privatisation in the forestry sector will not take place.

The shift towards a market economy will be limited to production assets, distribution of forest products on market principles and the implementation of payments for the use of forest resources. The decrees of the Cabinet of Ministers of the Ukraine (1992) and the normative rules have legalised a country-wide system of payments for special use of forest, such as for organised recreation. This system is based on different forms of property, on enhancing property rights and on economic evaluation of natural resources, particularly forest.

In comparison with forest units, the wood-processing and cellulose and paper industries were more prepared for new market conditions. These industries sufficiently changed their previous practice, and have introduced and enhanced property rights relevant to the new economic reality. Demonopolisation of state property, which was passed into the holdings of non-state forest industry enterprises, started in the early 1990s. As Table 4.2 shows, wood-processing enterprises, which have become collectively owned by the employees, appeared to be main producers in the industry in 1997. In cellulose and paper sectors they accounted for 99% of the production. Their labour force comprised accordingly 90% and 89% and the value of production assets of enterprises of this form of ownership accounted for 90% and 98%, respectively.

Table 4.2. Types of Property Regimes in Forest and Wood-Processing Industry (produce of enterprises by forms of ownership in 1997, % to total production)

Enterprises by forms of ownership	Forest and wood-processing industry, including	timber harvesting	wood-processing
State ownership	24.5	89.0	7.6
Collective ownership	75.1	11.0	91.8
Private	0.4	-	0.6
Totally	100	100	100

Source: Estimations based on the data from the National Academy of Sciences (1998)

Wood-processing and manufacturing facilities are gradually being privatised mainly through internal privatisation. It means that privatised wood product enterprises were formed as joint stock companies, where the employees have become shareholders. Managerial initiatives with the majority of shares were, however, siphoned off into the hands of the former command-and-control bureaucrats related to the corrupted government officials. Thus restructuring of management has not occurred. Also, though a legal framework for restructuring enterprises was established in 1992, the bankruptcy law makes this irrelevant because it permits companies to accumulate debts and then to close down, but it prevents restructuring (Kaufmann, 1998). Separate departments within wood-processing combines can therefore barely be privatised and they are not able to pursue their own commercial activity. Restructuring of production processes and an overall privatisation in the wood-processing industry has, in consequence, not taken place so far.

Privatisation of wood-processing production units was also carried out in an artificial way, with the assets passed to a property of employees for symbolic prices. No financial assets were brought into the ventures and funds remain inaccessible for the future investments as a result. The bureaucratic procedures with the involvement of four parallel State Committees on foreign direct investments and the unstable legal environment have in addition led to difficulty in attracting foreign investments in the sector. Consequently, there is a shortage of investments, without which the economic efficiency of forest enterprises remains inadequate, which further discourages investment.

Government additionally interferes considerably with the activity of privatised wood-processing units through specific price policies, complicated rules for enterprises' registration, ambiguous tax laws and customs rules, bureaucratic procedures for receiving government loans and credits, export and import licenses, substantially limiting economic liberalisation. So in the absence of a market, given imperfect information and high transaction costs, privatised enterprises are put in conditions that not only provoke spreading of the shadow economy, but also hamper the process of further developing open market relations. As a result, the performance and economic efficiency of the enterprises are lower than in the state plants: their outputs per capita of the labour force are lower, as are the outputs per value of the production assets (National Academy of Sciences, 1998). The majority of private and collectively owned enterprises is unprofitable and has debts, with their stagnation and failure being 96% attributed to high taxes (Shelley, 2000).

The enterprises in the Ukraine also usually continue to exist after bankruptcy. The bankrupt enterprises have three possibilities to keep on functioning. They can receive direct state subsidies, they can be allowed to delay tax payments and they can rely on inter-enterprise transmissions (Von Hirschhausen, 1998). In these conditions, despite the low economic efficiency of the privatised forest industry enterprises, few enterprise closures have taken place so far, and if the privatisation process in the forest sector has occurred, is not irreversible. Successful private firms or their profits could be expropriated to cross-subsidise unsuccessful firms. Risk of expropriation, the practice of financing unprofitable units at the account of profitable ones and government assistance to bankrupt enterprises, result in a heavy financial burden on the State budget. Besides, "asset stripping" is a popular method of extracting valuables, when enterprises are declared bankrupt. This situation continues to hamper entrepreneurs and threatens the long-term political sustainability of the privatisation process.

Moreover, there is no market to determine prices on forest products, and the stumpage fees that indicate the legitimately established lowest limit of the prices do not reflect the market prices. The prices for standing timber, which were claimed to be high, actually are substantially lower in comparison with the prices on the world market. Logging, road and transportation costs are twice as high as the stumpage fee (Shvidenko and Andrusishin, 1998). The price system in forestry that is mainly based on "cost-plus" estimates does not reflect the prices under market competition, and therefore serves to increase costs and leads to unsustainable forestry.

The prices on timber products, especially export prices, are partially set by the market, but costs often are not reflected in the market prices. The prices often fall lower than the production costs, because of the decreased domestic wood demand for construction and mining. Consequently, low economic efficiency of wood-processing enterprises with high level of barter as a measure to keep the enterprises functioning in the short term, leads to high transaction costs, providing scarce financial inputs into business and resulting in poor performance of the forest economy (Krott et al., 2000).

The state of affairs in forestry waned even more due to general economic problems in the country when the forestry sector as a part of the national economy faced financial instability, inflation, high interest rates, etc. The situation that leads to weak economic performance in the forestry sector also endangers the forest environment. High interest rates result in "mining of the resources" when the enterprises, despite officially existing norms of forest use, employ flexibility in timber harvesting. In such a way the Ukraine's forest policy that officially is focused on the expansion of wooded area and on environmental priorities conflicts with the interests of forestry units' management causing unsustainability in forestry. Hence, in the absence of economic liberalisation, privatisation and decentralisation, as necessary institutional strategies in the economy-in-transition, sustainable economic development of the forest sector remains elusive. Policy and market failures are preconditioned by the state of affairs in the economy in general and it is hardly possible to transform the practice of forestry without changing the economic system itself.

4.3. Human Factor of Institutional Changes

The human factor, which is in the focus of the current section, appears to be very important for changing the state of affairs in the Ukraine's economy and in its forest sector. People have to implement all political, societal and economic changes, because "people need organisations and institutions in which they feel at home, motivated and committed" (Vink, 1999). Therefore, a lot depends on public opinion about various issues of the institutional transformation, on the competencies, on public support of the reforms and on active involvement of individuals in the process of transition.

4.3.1. Competencies

Competencies include knowledge, experience, communication, motivation and trust. They are personified in codes of human behaviour and are much more stable and often much more resistant to change than formal rules (Slangen, 2000). Continuity of competencies in the Ukraine's forest sector is an acute problem, and likely it is not the level of social capital regarding knowledge and learning that is the main point of concern, but rather other aspects of informal rules, such as motivation and trust.

Traditionally, the Ukraine's silvicultural science and education are advanced (Gensiruk et al, 1995). Alongside the institutions that belong to the governmental structure of forest management (Figure 4.1) there are the Ukrainian State University of Forestry and Wood Technology, forest departments within the National Agricultural Academy, forestry colleges and forest schools. Therefore, despite a destabilised economy and certain shortcomings in the system of forestry education, which require efforts towards its improvement[30], the forest sector has got specialists and managers of various levels. The main problem of poor economic performance in forestry, regarding informal rules, is likely the lack of proper communication and reciprocity between the actors and the absence of their proper motivation, commitment and trust.

Violation of selling agreements and contracts, high transaction costs and poor co-operation are common features in the forest sector. Even if the enterprise can muster the expenses to apply to the arbitration court regarding the violation of business agreements and the decision of the court on payments is in favour of this enterprise, it does not mean that it will be paid. Informal sanctions (as using the "mafia") are often more effective in resolving conflicts between the enterprises (Ivanova and Nyggard, 1999), while the conflicts between business and authorities on tax payments are usually resolved through bribes (Raiser, 1997). The causes of the disputes often originate in low respect for the rules and also in lack of commitment and trust between the actors.

Trust promotes co-operation between people, and that co-operation leads to better performance of all institutions in the society, including the government (Shleifer and Vishny, 1998). Fell (1999) argues that in the post-communist countries institutions were "ill famed for a long time for their characteristic subjugating of individual interests in favour of those of the state and for their oppression of individual liberties". Consequently, lack of trust between the actors appeared to be a usual feature within political and civil institutions of the former communist countries. Both cultural (Fukujama, 1995) and institutional (North, 1991) theories of trust consider it to being based on experience. People in the post-communist countries are used to being

[30] International Tempus-Tacis Programme ENARECO focuses on economic issues of forest education.

motivated with commands rather than by their own opinions and interests such as entrepreneurial decisions, and they are hardly able to be receptive to institutional transformation and to be flexible in the changing environment. According to Shleifer and Vishny (1998), trust in the countries of Western Europe is on average between 45% and 65%, while in Eastern Europe it seldom reaches 30%.[31]

Table 4.3. Trust in Political and Civil Institutions by Country, 1996: Means (standard deviations)

Trust in:	Bul	Cze	Slk	Hun	Pol	Rom	Sle	Bel	Ukr
Government	2.7 (1.6)	4.6 (1.6)	3.7 (1.7)	3.2 (1.7)	3.5 (1.6)	3.3 (1.7)	3.7 (1.8)	3 (1.6)	2.4 (1.6)
Parliament	2.2 (1.4)	3.6 (1.5)	3.4 (1.5)	3.2 (1.6)	3.5 (1.5)	3.2 (1.6)	3.5 (1.6)	2.9 (1.6)	2.6 (1.7)
President	4 (1.9)	5.1 (1.8)	4.8 (1.7)	5 (1.8)	3.1 (1.7)	4.0 (2.1)	4.2 (2.0)	3.3 (1.7)	2.6 (1.8)
Civil Servants	2.9 (1.6)	3.7 (1.3)	3.7 (1.5)	3.8 (1.6)	3.5 (1.4)	3.4 (1.7)	4.1 (1.6)	3.2 (1.6)	3.0 (1.6)
Courts	2.8 (1.7)	4 (1.5)	3.8 (1.6)	4.3 (1.7)	3.9 (1.5)	4.1 (1.8)	4.1 (1.8)	3.5 (1.6)	3.2 (1.8)
Parties	2.5 (1.6)	3.7 (1.3)	3.2 (1.6)	2.8 (1.5)	2.6 (1.3)	3.0 (1.6)	2.8 (1.5)	2.7 (1.7)	2.4 (1.5)
Army	4.6 (1.9)	4.1 (1.5)	4.4 (1.6)	4.3 (1.7)	4.8 (1.6)	5.5 (1.6)	3.9 (1.9)	4.0 (1.8)	3.8 (1.9)
Police	2.9 (1.7)	3.9 (1.5)	3.7 (1.6)	4.2 (1.7)	4.1 (1.6)	3.8 (1.8)	4.0 (1.7)	3.2 (1.7)	2.8 (1.7)
Media	3.7 (1.8)	4.2 (1.4)	4.0 (1.5)	3.7 (1.60	3.9 (1.5)	3.2 (1.6)	3.8 (1.6)	3.7 (1.7)	3.7 (1.8)
Church	3.4 (2.0)	3.5 (1.8)	4.2 (2.0)	4.1 (1.9)	4.0 (1.9)	5.4 (1.8)	3.5 (2.0)	4.6 (2.0)	4.2 (2.1)
Patriotic societies	2.7 (1.8)	4.0 (1.4)	3.8 (1.6)	3.3 (1.6)	3.2 (1.4)	3.3 (1.8)	4.1 (1.7)	3.0 (1.7)	3.0 (1.7)
Farms	3.1 (1.8)	4.0 (1.4)	3.8 (1.4)	3.9 (1.6)	3.6 (1.5)	4.0 (1.9)	n.a. n.a.	3.7 (1.7)	3.3 (1.8)
Unions	2.5 (1.5)	3.4 (1.2)	3.4 (1.2)	3.5 (1.3)	3.0 (1.3)	3.4 (1.9)	3.2 (1.7)	3.0 (1.4)	2.7 (1.4)
Private enterprises	2.7 (1.8)	4.2 (1.4)	3.5 (1.7)	3.9 (1.6)	3.1 (1.5)	4.1 (1.9)	3.4 (1.7)	2.9 (1.8)	3.4 (1.9)
Foreign experts	2.5 (1.7)	3.6 (1.6)	3.2 (1.5)	3.3 (1.7)	2.9 (1.6)	3.4 (1.9)	3.5 (1.7)	3.1 (1.7)	3.2 (1.8)

Source: Rose, Mishler and Haerpfer (1997).

Note: Trust is scared on a 7-point scale with 7=maximum trust and 1 = minimum trust. BUL - Bulgaria; CZE - the Czech Republic; SLK - Slovak Republic; HUN - Hungary; POL - Poland; ROM - Romania; SLE - Slovenia; BEL - Belarussia; UKR - Ukraine. The sample for each country/institution range between 755 and 1000 cases.

Table 4.3 provides evidence that trust in political and civil institutions in the Ukraine is very low. It rates as one of the lowest even in comparison with the other countries of Central and Eastern Europe (CEE). Trust for the government that had to implement institutional changes in the late 1990s was especially weak, and only 7% of

[31] The percentage of people that answered "yes" when asked "would you say that most people can be trusted?"

Ukrainians believed that the government was "doing a good job" (Shelley, 2000). People believe more in the army, independent organisations or the church (Table 4.3). Their trust in farms, private enterprises and foreign experts is also reasonably above their worst expectations. Therefore, people likely are open to changes but they do not trust the bureaucrats and politicians.

This once more suggests moving away from a hierarchy mechanism of governance to a market mechanism with the involvement of new and more progressive policy actors in the action arena of the Ukraine's forestry. La Porta et al. (1997) have found a positive relation between trust and governance performance across the world, from which we may conclude that the lack of trust established with those who are governing in the Ukraine and between the policy principals holds back the institutional reforms. Low trust is also among the reasons for slow institutional transformation in the forest sector, and shifting the attitudes of the people towards favouring market changes, with increasing trust in those who implement the changes, would considerably enhance the process of transition.

4.3.2 Attitudinal diversity of forest policy actors: Q-methodology analysis

The objective of this section is to assess attitudinal diversity of the forest policy actors in the transitional period in order to find out the areas of conflict among them and to define their ideas on market changes and on sustainability in forestry. A Q-methodology approach based on a questionnaire was applied as a research tool. Q-methodology does not presume to define the number of people with certain views, but clarifies why people have their beliefs, and from which perspectives the attitudinal diversity can best be observed. Even several cases addressed with Q-analysis are suggestive in this respect, because they provide knowledge about the process. The methodology was used in political and social sciences to define Brazilian Attitudes toward Agrarian Reform (Peritore, 1990), to Measure Attitudinal Diversity of Siberian Forest Policy Makers (Mashkina, 1998), to Understand Participant Perspectives in National Forest Management (Steelman and Maguire, 1999), to realise Factors Influencing People's Participation in Forest Management in India (Lise, 2000), etc.

Data analysis in Q-methodology involves the sequential application of three sets of statistical procedures: correlation, factor analysis and computation of factor scores. The study method allows for a relatively simple data set, and the factor analytical tool makes it possible to analyse interviews even when the respondents have not explicitly revealed their opinions (Brown, 1986; McKeown and Thomas, 1988). There are two alternative directions established for the future development of the Ukraine's forest sector: (a) - towards a market economy or (b) - back to the command-and-control system, with two dimensions: (c) – with, or (d) - without concern of sustainability (Table 4.4).

We analyse the attitudinal diversity of fifteen forest managers from five[32] key forest areas, distinguishing their views about market changes with respect to sustainability in forestry. The investigation is mainly based on our personal knowledge of the interviewed people who were initially asked about their willingness to participate in the study. Then three forest managers per zone, of different age groups, education and position have been chosen for interviewing and they were sent normal distribution Q-sort cards with the statements (Appendix 4.1).

[32] Northern and Southern Steppe were considered jointly as a Steppe zone, because of the scarcity of forest resources and similar economic and environmental conditions.

Table 4.4. Q-Sample Design for the Q-Study on the Ukraine's Forestry Transition to a Market and Sustainability

Main Effects	Components	
A. Directions	**a)** pro-market economy	**b)** command-and-control system
B. Dimensions	**c)**sustainable development	**d)** low concern of sustainability
Combinations:	**ac**	**bc**
(A)(B)=(2)(2)= 4	**ad**	**bd**
Replication number (m)=6		
Q-Sample N = (A)(B) (m)	N=(2)(2)(6)= 24	

The problems that affected the forestry sector, economic, social, environmental and institutional have been identified in the statements and the participants were asked to rank each Q-statement according to their opinions. The answers are recorded on the scale ranging +3 through -3 (Appendix 4.2). "Plus three" indicates complete agreement and "minus three" complete disagreement, with zero indicating a neutral attitude towards the statement. Then the data is run through a factor analysis (Q-method: software, 1986). A factor analysis is used to reduce the dimensionality of the data by creating new uncorrelated variables. It is a method that translates a large set of variables that are often highly correlated into a few independent choice variables or into a set of principal components, known as factors. The forestry areas, by which the respondents have been chosen, were defined via the spatial classification of Ukrainian forests (Gensiruk and Nijnik, 1995) that is presented in Chapter 5.

The results of the analysis provide the identification of the groups with similar views, according to the orientation of the blocks of statements (page 4 of Appendix 4.3, Rank Statement Totals). The analysis indicates the existence of two main groups of attitudes regarding market reforms. The perceptions of the protagonists on sustainable development of the forest sector and on the protection of natural resources are also distinguished (page 4 of Appendix 4.3, Rank Statement Totals with factors 1,2,3 and 4). The first group of the actors has a belief that only radical institutional transformation towards a market economy will result in a breakthrough in the development of the forest sector. The respondents consider the market as an important attribute of sustainable development of forestry (page 5 of Appendix 4.3, Distinguishing Statements for factor 1). The second group of forest managers has a command-and-control economy orientation. The actors blame radical economic reform for the problems in forestry and are in favour of centralised government planning regulation (page 5 of Appendix 4.3, Distinguishing Statements for factor 4). They support their opinion by citing the environmental problems that arose during the transitional period.

There are also two other groups of the actors, the first of which is supporting market reforms but considering sustainability issues not very important (page 5 of Appendix 4.3, Distinguishing Statements for factor 2). This group blames all the problems on the existing legislative system; tax policy; corruption; high interest rates; difficulties with new investments; high costs of energy, fuel and raw materials; and other features of the transitional period. The last group of forest managers supports a command-and-control economy and does not have a clear opinion about sustainability in forestry (page 5 of Appendix 4.3, Distinguishing Statements for factor 3).

The investigation via forestry zones indicates that the respondents from the Polissja and the Carpathian regions support radical reforms directed towards implementation of a market economy in the forest sector. In the Carpathians, the stress is further placed on sustainable development and the protection of natural resources.

This could be explained by high non-timber values of forest in this area, e.g. its potential for outdoor recreation and richness in biodiversity. The attitudes of the respondents from the Wooded Steppe and Steppe zones reflect their preoccupation with the problems of protecting natural resources and sustainable development. This could be explained by the special position of the forest industry in these areas. Forestry comprises just a small part of the regional economies, while environmental problems are acute both for the Wooded Steppe zone and for the Steppe. The same explanation could be applied for the Crimea, where the respondents pay particular attention to the environmental problems of the Black Sea area (page 1 of Appendix 4.3, Factor Matrix I, Q-Sorts =15, 3 from each zone respectively).

The social perspective of the study shows that the forest managers and engineers in the age range 24-38 mainly support radical economic reform but have little concern for the problems of sustainability in forestry. The respondents over 40 care about nature conservation and sustainability issues (page 4 of Appendix 4.3, Factor Matrix I). Pro-market attitudes with concern about sustainability prevail among local administrative staff and managers, and it was not the case some 5-7 years ago (Ukraine Today, 2000). In contrast, attitudes of the workers appeared to change in resistance to market reform. This could be explained by the decreasing economic activity and instability in the forest sector, and by the declining income of the workers (page 2 of Appendix 4.3, Factor Matrix II).

The results of the Q-analysis have not distinguished differences in opinions of female and male respondents; neither in their views regarding the economic reform, nor with respect to sustainable development of the forest sector (page 2 of Appendix 4.3, Factor Matrix I). However, it was found that of the actors with a comparatively high salary (more than 200 Hr per month[33]), both men and women support radical market changes and are concerned with the problems of sustainability in forestry. The low-paid respondents do not care about these problems (page 3 of Appendix 4.3, Factor Matrix II), and that could be explained by increasing economic difficulties during the transitional period that have become an especially heavy burden for people with low salaries. Also, the forestry actors, who have worked in the sector for 10 years and longer are in favour of the reformation and are concerned with the problems of sustainable forestry development (page 3 of Appendix 4.3, Factor Matrix I). This observed opinion shows that knowledge and experience provide a better understanding of the necessity of the institutional transformation in forestry towards a market economy.

The results of the analysis enable us to identify differences in the forest actors' attitudes on market changes and sustainable development. The attitudinal diversity appears to be dependent on the age and living conditions of the respondents and still more so on their competencies, such as working experience, position, etc. The study identifies forest areas in which support of the reforms is weak, and enables us to discuss the reasons for that. It also provides important insights for understanding why certain governmental forest policies are unfavourably received by one group of the actors, or in one forestry zone, and favourably received elsewhere. Through the different importance accorded to the problems of transition by the forestry actors, we become aware of the priorities existing in forestry and of the factors that most hamper the process of transition. The results serve as an initial basis for considering the human factor in the process of institutional transformation and for advising on policy decisions to promote public support of the reforms.

[33] About 45 USD, to compare with an average salary of a teacher that is 19 USD (Ukraine Today, 2000).

4.3.3. The framework of institutional transformation

The intensity and irreversibility of political, economic and social reforms depend on pressures on the stock of institutions coming from the world's economic system and the international community, as well as on pressure arising within the forest sector itself. For a better understanding of the processes that are taking place in the forest sector of the Ukraine, the framework of institutional transformation has been developed.

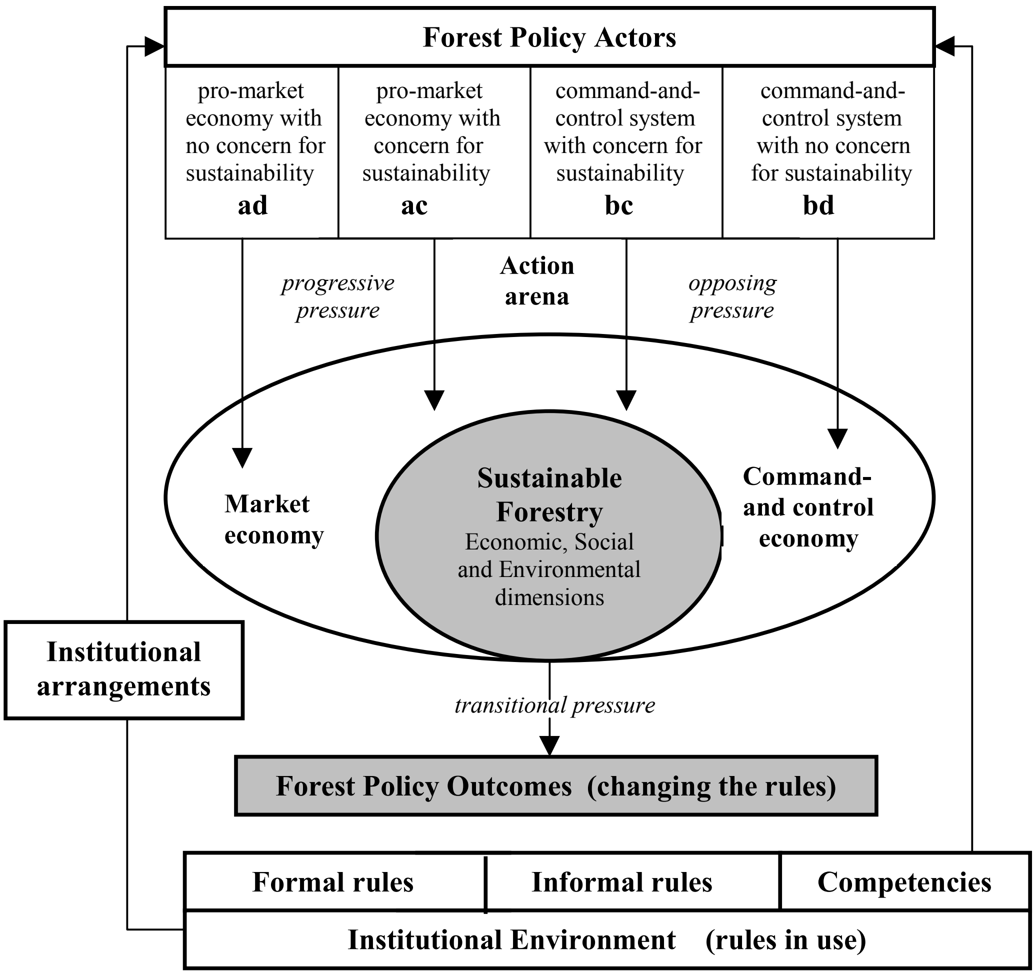

Figure 4.2.The Framework of Institutional Transformation in Forestry-in-transition
Source: Based on North (1993), Slangen (2000) and the results of the study

As we see from Figure 4.2, processes taking place in the system include the interaction between key institutional blocs, the institutional environment and the arrangements made for the active participation of the policy actors. The forest policy actors "ac" and "ad" discussed in the previous section, who are oriented towards a market stand for progressive pressure that originates with those who are involved in the process of transition and who support it, bringing new ideas and initiating changes. These progressive movements towards the reforms have to offset the inertia-ridden and opposing pressure "bc" and "bd" defined in the previous section, that protects the former institutions. The enhancement of the reforms in the Ukraine's forestry depends on the force of the “ac” and “bc” actors and on their competencies, which play a crucial role in the process of transition. [34]

Figure 4.2 shows that it is in the action arena that the main bottlenecks are observed between pro-market oriented forest policy actors and the command-and-control system supporters with and without concern for sustainable development. The forest policy outcomes are influenced by the actors and depend on their competencies and capabilities, positively correlating with their power. The victory of the progressive forces in the action arena is a basic prerequisite for changing the rules of the game and for successful institutional transformation of the Ukraine's forestry.

The transition of the institutions in forestry has already started, but given that support of market reforms and opposition to them are still in relative equilibrium (Ukraine Today, 2000), the crucial task is to accelerate institutional changes. The institutions have to be further developed via improvement of the legislative system, transition of the government and upgrading of the social capital. "Institutional reforms should be pushed very fast wherever the circumstances warrant, and may need to be postponed in other areas or occasionally slowed down - in order to allow complementary development to catch up, absorptive capacity to grow, or public tolerance to be rebuilt (cf. Schrieder, 2000)". Understanding of institutional transformation requires a long-term perspective, and it is necessary to study policy developments over at least 10 years in order to explain the change (cf. Andersson, 1999). Upcoming studies will examine the evolution of attitudes of the forest protagonists in order to know the pace of pro-market transformation and to make judgements about the success of the reforms, with projections for the future development of forestry towards sustainability.

4.4. Changing the Rules of the Game: Discussion

The study reveals that the institutional environment now incorporates many features of the prior command-and-control system, and it is often responsible for inertia in the process of institutional transformation. Therefore, the first task is to change the "rules of the game". Together with speeding up the progressive alteration of the institutional environment, the gap between legislative rules and their implementation should be eliminated via the enhancement of proper institutional arrangements. This involves the transition of the governance, with the creation of new industrial networks based on market criteria, such as prices, costs, profits, efficiency and competition. The market has to determine the prices of property and goods, and private investors should be able to realise the returns on their financial inputs into forestry development.

Thus the first problem concerns formal rules in the Ukraine's forestry, where the most important question is to settle the structure of ownership and to ensure stakeholders' rights to use forest resources for their own benefits on terms which are well-defined and enforced. The country’s legal documents regarding forests have to redefine and enforce property rights on forest resources and wooded lands through the introduction alongside with State forests of community managed forests (not a common property[35]) and private forests (cf. Carlsson, 1999). I agree with Carlsson that

[34] For identification of forest policy actors (ad, ac, bc and bd) see section 4.3.2

[35] For explanation of the differences between common property and community managed forests see Carlsson (1999). Using the Swedish forest commons as an example for Russia, he argues that an introduction of community managed forests is an alternative to massive privatisation, as well as to undesirable continuation or strengthening of state forest management.

privatisation of forests is only one option. The forest inventory of the Ukraine has to comprise the State forest fund, non-state forest fund (municipalities, farmers, enterprises, organisations and institutions, privately owned wooded lands) and the fund of afforestation. The afforestation fund will include state, communal and private lands ready to be sold or leased to various stockholders for forest development.

Successful development of forest sector in the country-in-transition, such as the Ukraine, very much depends on the success of institutional transformation. However, the capacity to generate a simultaneous change in a whole range of political, economic and social institutions is limited. Therefore, it is vital to economise and find a feasible time-path for step-wise reforms that do not totally unhinge the macroeconomic balance (cf. Eggertsson, 1994). Today the Ukraine does not have the institutional framework that "is able to handle such a dramatic change in property rights" (cf. Carlsson, 1999) as privatisation of forests. Thus restructuring of rural areas and transformation of economic activity in forestry towards a market economy should proceed more intensively, though carefully. The alternative for an overall transition to markets is to create a favourable setting for alternative forms of organisation and to establish a selection process via which the winners between organisations are selected on an economic criterion, and those who minimise social costs win (cf. Schrieder, 2000).

Privatisation is definitely the best solution to enhance cost-efficiency and quality of production in the wood-processing sector of the Ukraine. When assets are publicly owned the manager is not the owner and he receives only a fraction of returns. He has weak incentives to make the investments to reduce costs and to improve quality or bring innovations. Privatisation facilitates the process of enterprisation that makes a shift towards cost-efficiency and quality improvements in the wood-products industry. Thus the process of privatisation of wood-processing and manufacturing facilities should proceed intensively, and besides privatisation of separate enterprises, the State has to ensure legitimacy and feasibility of privatisation of the departments and the production units within the forest industry combines, with their managerial restructuring. In order to approach sustainability, which is preconditioned by successful transition of the institutions, wood-processing and manufacturing economy, have to shift to a market radically, not incrementally. However during the transition, when market incentives of sustainable use of the resources are not workable the State has to enhance responsibilities of forest protection agencies and local governance to control the state of affairs in forestry, especially with regard to timber harvesting.

4.5. Conclusions

There is a general consensus that the objective of an economic system transformation in transition countries, such as the Ukraine, is the creation of an effective market oriented economy of a European type. Institutional transformation in the Ukraine's forestry has already started, though the rules of the game and the arrangements have not changed substantially so far. Neither democratisation with open privatisation nor decentralisation, have been achieved. Governance is an authority, without properly functioning market incentives. The main idea, therefore, is to enhance the changes. Together with institutional environment and institutional arrangements that govern in the system, the human factor appears to be important for successful implementation of market reforms. Changing the motivations of the actors, directing them in support of the reforms and increasing their capacities via uprising of their commitment and trust will substantially enhance policy outcomes and promote sustainable development of forestry. Though the analysis has shown the support of market changes, actors' attitudes on the process of institutional transformation and on sustainability in forestry differ considerably. Pro-market and command-and-control oriented groups, with another two groups of attitudes concerning sustainability in forestry, discussed in section 4.3.2 provide understanding of the present nature of economic behaviour in the forest sector and the actors' perceptions on sustainability.

The proposed key policy measures to enhance institutional transformation of forestry on its way towards sustainability are: definition and insurance of property rights; incorporation of open market changes in the forest policy design; restructuring of the production processes, economic dispositions and management; economic liberalisation; elimination of the grabbing hand model of the government; promotion of collective action; enhancement of social capital with shifting of the mentality of the forest policy actors towards a market economy. Important issues are sequencing and timing of the reforms.

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Appendix 4.1.
The Statements[36]

(ac) *pro-market economy orientation with concern of sustainability in forestry*

1. Appropriate economic and institutional reform that introduces changes of property rights and their insurance, as well as the involvement of international investments into the forestry sector will cause a break through in the development of forestry.
2. Complete freedom of productive activity with market structural changes in the forest sector will stimulate wood production and enhance sustainable forest management.
3. If forest enterprises and land are privatised and the market is allowed to operate without interference from the authorities, so that owners can collect the economic rents, then forest economy will improve and forest resources will become more valuable to users, promoting sustainability in forestry.
4. Market should balance demand and supply sides of the forest industry production via prices. Today prices on Ukrainian timber are underestimated considerably. Market will increase prices and thus address environmental goals.
5. Increasing investments in forestry and in its technological modernisation with the introduction of more qualified labour (training courses, foreign specialists) would considerably improve the performance of the forestry enterprises.
6. Growing international trade will support the market via increasing demands for forest products and through the implementation of environmental requirements (sustainable production).

(bc) *command-and-control system orientation with concern of sustainability in forestry*

7. Only centralised government investments and administrative control system could promote successful development and sustainability in the forest sector. The State has enough financial possibilities to support forest economics and its technological innovation.
8. Current laws and legislative rules are sufficient and really helpful for the forest sector production and for its sustainable development.
9. Wood production activity under strict ministerial control does not contradict with the sustainable forestry management. However the transition to a market leads to the fact that more than 30% of timber harvesting is not reflected in the official statistic reports.
10. Low level of forestry production is caused only by the process of structural transformation and by the decreasing co-operation within the CIS and CEE countries. The governmental planning-control system provided all necessary guaranties to meet economic and environmental demands.
11. There is no necessity to switch the mentality of all actors from common property to private. Previously existed incentive system in the forest industry practice met the requirements of the producers and supported sustainable forestry development.
12. Without governmental demands it is impossible for forest enterprises to perform in the market. It is also impossible to balance volumes of production with sustainability of the environment.

(ad) *pro-market economy orientation without concern of sustainability in forestry*

[36] The diversity of problems existing in the forestry and various approaches to their solution that were distinguished via Q-analysis suggest that these initial statements have to be further improved.

13. Privatisation in Ukraine's forestry will positively influence productive activity of forestry enterprises, their better performance in the market. However, it will cause a decrease of environmental demands and will lead to job losses.
14. Transition to a market economy will expand export of forestry industry products but will result in unpredictable increase of forest harvesting.
15. The preservation of the existing forests is hardly one of the main directions of the forest policy during the period of transition to a market. Volumes of timber harvesting mainly depend from the marker demands.
16. High prices of energy, fuel and raw materials and market competition for forest industry products have caused acute attention to economic issues and resulted in low level of financial support of environmental reforms.
17. High interest rates on new credits and investments for the privatised forestry units caused problems to further implement structural changes. Market reforms under particular conditions of the country have adversely affected sustainable development of forestry.
18. In transition period, some 30% of forestry industry production are done by barter and through third persons. Because of that there is no financial opportunities to provide financial inputs in environmental protection.

(bd) *command-and-control orientation without concern of sustainability in forestry*
19. Planing-control system will allow to stabilise the economy, to increase production and consumption of forest industry products, but will once again distract sustainable forest management.
20. Forests were degraded because to meet output targets, under planning-control system, the managers of forest and wood-processing enterprises substituted the undervalued forest resources for other, harder-to-obtain inputs. Besides, stumpage fees were inappropriate.
21. Still existing administrative-regulatory system is focused on economic targets (volumes of output). Government regulates prices on forest industry products and levels of their consumption, environmental values and human dimensions in these conditions are underestimated.
22. Volumes of timber harvesting depend from governmental voluntary decisions, which are sometimes replaced by personal desires (corruption). This situation distorts sustainable forestry management.
23. Under government control there is no concern about the environment, because people are not involved in real decision-making and also because half of the forest industry personal staff has not got necessary environmental management training.
24. Forests are used unsustainably under conditions of a planned administrative regulation, because there are no property rights that protect individuals from investing in forestry management improvements (e.g., by planting trees).

Appendix 4.2. Normal Distribution of the Q-sort[37]

Disagree -3	-2	Neutral -1	0	Agree +1	+2	+3

Name
Sex
Age
Education ______, Occupation _____,
How long do you work in forest sector? ____
Salary ______________________, Marital status ______________,
Children __________

Appendix 4.3. Q-Analysis

Rotating Angles Used Between Factors

FTR#1	FTR#2	ANGLE
1	2	-13.

PAGE 1 (by forestry areas)
Factor Matrix I with **X** Indicating a Defining Sort[38]

QSORT [39]	Loadings 1	2	3	4
1 P	0.6480**X**	0.1471	0.1470	-0.1341
2 P	0.8235**X**	0.1735	-0.1131	-0.3967
3 P	-0.5317	0.1552	-0.0324	0.6305**X**
4 F-S	0.1498	0.8040**X**	-0.0318	0.2544
5 F-S	0.8399**X**	-0.0683	-0.0308	-0.1953
6 F-S	-0.0169	0.8225**X**	0.0962	-0.1423
7 S	0.1171	0.2507	0.8564**X**	-0.1007
8 S	-0.6697	-0.2044	0.2210	0.5239**X**
9 S	0.4101	0.2974	-0.1134	-0.7524
10 C	-0.1453	-0.1527	0.7240**X**	0.3210
11 C	0.7462**X**	0.0399	-0.1155	-0.4758
12 C	-0.0482	0.4121	0.0821	0.8307**X**
13 Cr	-0.5444	-0.1900	0.1356	0.6677**X**
14 Cr	0.8580**X**	-0.0907	0.0998	0.0598
15 Cr	-0.1656	0.4309	-0.4566	0.5950**X**
% expl.Var[40].	29	13	11	22

[37] For measuring the attitudes, the respondents are to judge a set of statements (Appendix 4.1). There is an example of the form used for interviewing fifteen forest managers by five forestry zones of the Ukraine. The statements are scaled as an integer value in a range of -3 to +3.
[38] Dominating indicators are those with factor loading ≥ 0.5 or ≤ -0.5.
[39] P - for the Polissja; F-S - for the Wooded Steppe; S - for the Steppe; C - for the Carpathians; Cr - for the Crimea
[40] the first factor explains 29% of the variation, the second, 13%, etc.

PAGE 2 **Appendix 4.3.(**female/male)

Factor Matrix I with **X** Indicating a Defining Sort

QSORT		Loadings 1	2	3	4
1		0.8235**X**	0.1735	-0.1131	-0.3967
2		0.8399**X**	-0.0683	-0.0308	-0.1953
3		-0.0169	0.8225**X**	0.0962	-0.1423
4		0.1171	0.2507	0.8564**X**	-0.1007
5		-0.0482	0.4121	0.0821	0.8307**X**
6	female/	-0.1656	0.4309	-0.4566	0.5950**X**
7	/male	0.6480**X**	0.1471	0.1470	-0.1341
8		-0.5317	0.1552	-0.0324	0.6305**X**
9		0.1498	0.8040**X**	-0.0318	0.2544
10		-0.6697	-0.2044	0.2210	0.5239**X**
11		0.4101	0.2974	-0.1134	-0.7524
12		-0.1453	-0.1527	0.7240**X**	0.3210
13		0.7462**X**	0.0399	-0.1155	-0.4758
14		-0.5444	-0.1900	0.1356	0.6677**X**
15		0.8580**X**	-0.0907	0.0998	0.0598
% expl.Var.		29	13	11	22

PAGE 2 (managers/technicians and workers)[41]

Factor Matrix II with **X** Indicating a Defining Sort

QSORT	Loadings 1	2	3	4
1	0.6480**X**	0.1471	0.1470	-0.1341
2	0.8235**X**	0.1735	-0.1131	-0.3967
3	0.1498	0.8040**X**	-0.0318	0.2544
4	0.8399**X**	-0.0683	-0.0308	-0.1953
5	0.1171	0.2507	0.8564**X**	-0.1007
6	-0.1453	-0.1527	0.7240**X**	0.3210
7	0.7462**X**	0.0399	-0.1155	-0.4758
8	0.8580**X**	-0.0907	0.0998	0.0598
9	-0.1656	0.4309	-0.4566	0.5950**X**
10	-0.5317	0.1552	-0.0324	0.6305**X**
11	-0.0169	0.8225**X**	0.0962	-0.1423
12	-0.6697	-0.2044	0.2210	0.5239**X**
13	0.4101	0.2974	-0.1134	-0.7524
14	-0.0482	0.4121	0.0821	0.8307**X**
15	-0.5444	-0.1900	0.1356	0.6677**X**
% expl.Var.	29	13	11	22

[41] managers are holders of university diplomas, while technicians and workers not

PAGE 3 (working experience in forestry more than 10 years/less)

Factor Matrix I with **X** Indicating a Defining Sort

QSORT	Loadings 1	2	3	4
1	0.6480**X**	0.1471	0.1470	-0.1341
2	0.1498	0.8040**X**	-0.0318	0.2544
3	0.8399**X**	-0.0683	-0.0308	-0.1953
4	0.1171	0.2507	0.8564**X**	-0.1007
5	-0.1453	-0.1527	0.7240**X**	0.3210
6	0.7462**X**	0.0399	-0.1155	-0.4758
7	0.8580**X**	-0.0907	0.0998	0.0598
8	-0.1656	0.4309	-0.4566	0.5950**X**
9	0.8235**X**	0.1735	-0.1131	-0.3967
10	-0.5317	0.1552	-0.0324	0.6305**X**
11	-0.0169	0.8225**X**	0.0962	-0.1423
12	-0.6697	-0.2044	0.2210	0.5239**X**
13	0.4101	0.2974	-0.1134	-0.7524
14	-0.0482	0.4121	0.0821	0.8307**X**
15	-0.5444	-0.1900	0.1356	0.6677**X**
% expl.Var.	29	13	11	22

PAGE 3 (salary more than 200 Hr/less)

Factor Matrix II with **X** Indicating a Defining Sort

QSORT	Loadings 1	2	3	4
1	0.6480**X**	0.1471	0.1470	-0.1341
2	0.1498	0.8040**X**	-0.0318	0.2544
3	0.8399**X**	-0.0683	-0.0308	-0.1953
4	-0.0169	0.8225**X**	0.0962	-0.1423
5	0.1171	0.2507	0.8564**X**	-0.1007
6	-0.1453	-0.1527	0.7240**X**	0.3210
7	0.7462**X**	0.0399	-0.1155	-0.4758
8	0.8580**X**	-0.0907	0.0998	0.0598
9	-0.1656	0.4309	-0.4566	0.5950**X**
10	0.8235**X**	0.1735	-0.1131	-0.3967
11	-0.5317	0.1552	-0.0324	0.6305**X**
12	-0.6697	-0.2044	0.2210	0.5239**X**
13	0.4101	0.2974	-0.1134	-0.7524
14	-0.0482	0.4121	0.0821	0.8307**X**
15	-0.5444	-0.1900	0.1356	0.6677**X**
% expl.Var.	29	13	11	22

PAGE 4 (age under 38/over)

Factor Matrix I with an **X** Indicating a Defining Sort

QSORT	Loadings 1	2	3	4
1	0.8235**X**	0.1735	-0.1131	-0.3967
2	-0.5317	0.1552	-0.0324	0.6305**X**
3	0.8399**X**	-0.0683	-0.0308	-0.1953
4	0.4101	0.2974	-0.1134	-0.7524
5	0.7462**X**	0.0399	-0.1155	-0.4758
6	-0.5444	-0.1900	0.1356	0.6677**X**
7	0.8580**X**	-0.0907	0.0998	0.0598
8	0.6480**X**	0.1471	0.1470	-0.1341
9	0.1498	0.8040**X**	-0.0318	0.2544
10	-0.0169	0.8225**X**	0.0962	-0.1423
11	0.1171	0.2507	0.8564**X**	-0.1007
12	-0.6697	-0.2044	0.2210	0.5239**X**
13	-0.1453	-0.1527	0.7240**X**	0.3210
14	-0.0482	0.4121	0.0821	0.8307**X**
15	-0.1656	0.4309	-0.4566	0.5950**X**
% expl.Var.	29	13	11	22

PAGE 4

Rank Statement Totals with Each Factor

No.	Statement	No.	Factors 1		2		3		4	
1	Appropriate economic and institutional	1	1.37	2	0.04	10	-1.12	20	-1.09	20
2	Complete freedom of productive will	2	1.51	1	1.34	4	-1.36	22	-1.54	23
3	Privatisation in forest industry is	3	1.05	6	-0.28	15	-0.44	14	-1.86	24
4	Market should balance demand and	4	0.51	7	0.32	9	-0.66	16	-0.41	14
5	Increasing investments in forestry	5	1.16	5	1.34	4	0.68	8	0.32	10
6	Growing trade will support the market	6	1.28	3	0.98	6	0.46	10	0.46	9
7	Centralised government investments	7	-1.57	24	-0.67	18	-1.14	21	1.31	3
8	Current laws and legislative rules	8	-0.79	18	0.00	13	-0.46	15	0.02	13
9	Transition to the market caused	9	-1.19	19	-0.63	17	0.22	12	0.68	8
10	Low level of timber production is	10	-1.31	21	-1.02	20	-0.70	18	0.75	7
11	There is no necessity to switch	11	-1.34	22	0.71	8	0.92	5	1.06	5
12	Without governmental demands it is	12	-0.77	17	1.37	2	0.90	6	1.06	4
13	Privatisation will improve the	13	0.50	8	-1.37	22	-0.90	19	-1.25	22
14	Transition to the market wiil expand	14	-0.02	15	1.37	2	0.68	8	-0.61	18
15	Preservation of forests is not the	15	0.46	9	0.00	13	1.58	2	-0.42	15
16	High costs of energy, of fuel and	16	0.31	11	-1.65	24	1.82	1	-0.70	19
17	High interest rates on credits have	17	1.22	4	-1.06	21	0.66	9	0.30	12
18	In transition period 30% of forest	18	0.22	12	-0.35	16	1.17	3	1.05	6
19	Planning-control system is able to	19	-1.41	23	-0.04	14	-1.60	24	1.49	1
20	Forests were degraded because of	20	0.36	10	-1.65	24	-0.68	17	-1.25	21
21	Still existing administrative-	21	0.03	14	1.30	5	0.00	13	1.48	2
22	Volumes of timber harvesting depend	22	0.10	13	0.00	13	-1.39	23	0.31	11
23	Under government control	23	-1.19	20	0.95	7	0.92	5	-0.56	16
24	Forests are used unsustainable	24	-0.49	16	-0.98	19	0.44	11	-0.58	17

Distinguishing Statements for Factor 1

Both the Factor Q-Sort Value and the Normalized Score are Shown.

No.	Statement	No	1 RNK	1 SCORE	2 RNK	2 SCORE	3 RNK	3 SCORE	4 RNK	4 SCORE
1	Appropriate economic and institutional reform will in	1	3	1.37*	0	0.04	-2	-1.12	-2	-1.09
3	Privatisation in forest industry is improved its posi	3	1	1.05*	0	-0.28	0	-0.44	-3	-1.86
13	Privatisation will improve the performance of forest	13	1	0.50*	-2	-1.37	-1	-0.90	-2	-1.25
20	Forests were degraded because of administrative plann	20	0	0.36*	-3	-1.65	-1	-0.68	-2	-1.25
16	High costs of energy, of fuel and raw materials cause	16	0	0.31*	-3	-1.65	3	1.82	-1	-0.70
12	Without governmental demands it is impossible success	12	-1	-0.77*	3	1.37	1	0.90	2	1.06
23	Under government control there is no concern ab	23	-2	-1.19	1	0.95	2	0.92	-1	-0.56
11	There is no necessity to switch mentality to the "pri	11	-2	-1.34*	1	0.71	2	0.92	2	1.06

Distinguishing Statements for Factor 2

No.	Statement	No.	1 RNK	1 SCORE	2 RNK	2 SCORE	3 RNK	3 SCORE	4 RNK	4 SCORE
1	Appropriate economic and institutional reform will in	1	3	1.37	0	0.04	-2	-1.12	-2	-1.09
19	Planning-control system is able to stabilise the econo	19	-3	-1.41	0	-0.04*	-3	-1.60	3	1.49
17	High interest rates on credits have created new diffic	17	2	1.22	-2	-1.06*	1	0.66	0	0.30
16	High costs of energy, of fuel and raw materials caused	16	0	0.31	-3	-1.65	3	1.82	-1	-0.70

Distinguishing Statements for Factor 3

No.	Statement	No.	1 RNK	1 SCORE	2 RNK	2 SCORE	3 RNK	3 SCORE	4 RNK	4 SCORE
16	High costs of energy, of fuel and raw materials cause	16	0	0.31	-3	-1.65	3	1.82*	-1	-0.70
15	Preservation of forests is not the main priority in t	15	1	0.46	0	0.00	3	1.58*	0	-0.42
24	Forests are used unsustainable under planned adminstr	24	-1	-0.49	-1	-0.98	0	0.44	-1	-0.58
22	Volumes of timber harvesting depend from governmental	22	0	0.10	0	0.00	-3	-1.39*	0	0.31

Distinguishing Statements for Factor 4

No.	Statement	No.	1 RNK	1 SCORE	2 RNK	2 SCORE	3 RNK	3 SCORE	4 RNK	4 SCORE
19	Planning-control system is able to stabilise the ec	19	-3	-1.41	0	-0.04	-3	-1.60	3	1.49*
7	Centralised government investments promotes succes	7	-3	-1.57	-1	-0.67	-2	-1.14	2	1.31*
10	Low level of timber production is caused by the proe	10	-2	-1.31	-2	-1.02	-1	-0.70	1	0.75*
23	Under government control there is no concern b	23	-2	-1.19	1	0.95	2	0.92	-1	-0.56
16	High costs of energy, of fuel and raw materials caue	16	0	0.31	-3	-1.65	3	1.82	-1	-0.70
3	Privatisation in forest industry is improved its poi	3	1	1.05	0	-0.28	0	-0.44	-3	-1.86*

5. CONTRIBUTION OF AFFORESTATION STRATEGY TO SUSTAINABLE MANAGEMENT OF THE RESOURCES

The diverse nature of rural developments has changed our views on the role of forests. Recently, an important move in the debates around the expansion of wooded lands is observed in the direction of multiple, economic, environmental and social forest functions. The objective of this chapter is to provide innovative perspectives on the role of afforestation in the Ukraine, a sparsely wooded country with acute environmental problems, which has good forest growing conditions but imports timber. I attend to the challenge of planting forests on bare and marginal agricultural lands and, by using a simulation technique and employing a cost-benefit analysis, as an evaluation criterion, reveal that afforestation for multiple purposes is a proper means to address sustainability in the Ukraine's rural development.

5.1. Introduction

Today, when the traditional concept in forestry is to be left, and a sustainable forest management for multiple benefits is required (Montalembert and Schmidthusen, 1993), a discussion has begun around the role of afforestation and reforestation in realising sustainability (IFF, 1999). Afforestation is an expansion of forest area on lands, which more than 50 years ago contained forests, but later, have been converted to some other use. Reforestation is seen as a restoration of degraded or recently (20-50 years ago) deforested lands (IBN-DLO, 1999). Afforestation and reforestation of marginal lands is seen as a long-term means to rise wood production and to enhance multi-functional role of forests. Planting trees is an instrument for mitigating climate change, expanding recreational use of forests, and enhancing all environmental forest functions, which are concurrently considered to be economic functions (Pearce, et al., 1999).

In view of the environmental situation in the Ukraine, of which 15 % lies in the zone of an extreme environmental pressure (Ministry of Environmental Protection, 1993), and taking into account the role that forests play in the environment and their low share, extended forest regeneration is an important sustainable forest policy measure. Land is to be allocated to those users and be used for those purposes, which maximise as much as possible its aggregate social value. If the social value (Perman et al., 1996, p.251) of wooded land is higher than the social value of this land when used for other purposes, afforestation is reasonable. Financial returns, therefore, from forest management are to be adjusted to shadow values to reflect the true opportunity costs of the forest resources and to account for environmental and social externalities.

This chapter substantiates afforestation and reforestation as a long-term policy for sustainable management of the resources. The programme of afforestation (Gensiruk and Nizhnik, 1995) is proposed as a policy measure to realise sustainability criteria in forestry defined in Chapter 3. While Chapter 6 discusses the role of newly planted forests in mitigating climate change, this chapter focuses on timber supply and soil protection role of the projected forest plantations. In the starting sections of Chapter 5, I present the state of affairs with forest regeneration and reforestation in the Ukraine and define the objectives of the expansion of forest cover. In section 5.3, I assess afforestation potential of the country, estimate afforestation costs and benefits with the programme. I provide empirical evidence that low share of forest cover is among the causes of erosion in the Ukraine, and that planting trees is a sound policy measure to alleviate the erosion. The evaluation of soil protection role of forests is a complement to initial assessment of timber supply benefits from the newly established forest plantations. If the programme adds to the welfare of the society, its implementation is reasonable. Initial cost-benefit analysis of the proposed programme and an LP model that serves a basis for policy analysis, are deliberated at the end of this chapter. The conclusion on land use changes in rural areas of the Ukraine ensues.

5.2 Afforestation and Reforestation in the Ukraine: Management for Sustainability

5.2.1. Wooded area

Initially forests were spread almost all over the territory of the Ukraine with the exception of the Steppe zone. The Polissja, the Carpathian and the Crimean mountains had almost unbroken forest cover (Figure 1).

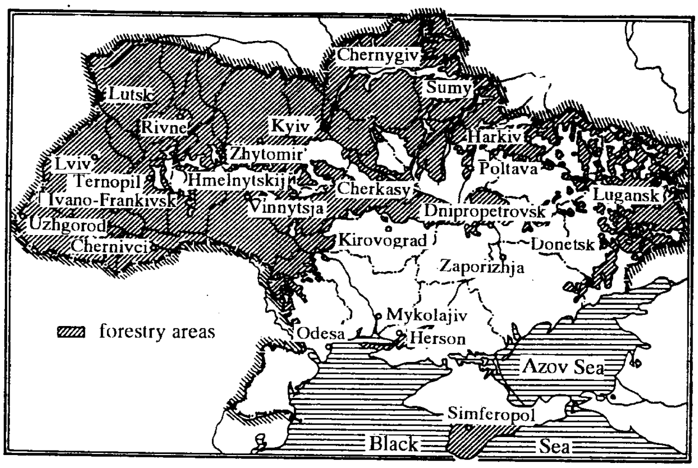


Figure 5.1. Originally wooded area (the first millennium AD)
Source: Gensiruk and Nizhnik (1995)

Under the pressure of human activity forest area has decreased during the last 500 years to one third, while species composition and age structure of the stands have been changing. In the 18th and 19th centuries, economic development and growing demands for timber resulted in high rates of deforestation. In great quantities timber was used for the industry as a raw material and fuel, in construction and railways building. Besides, it played a leading role in export. Figure 5.1 presents the map of forests in the first millennium AD. Its comparison with the map of forests in the 20th century (Figure 5.2) testifies to considerable forest depletion. Deforestation, according to FAO and IGBP definition, is a 10% or more decline of forest crown cover and a conversion of the former wooded areas to another land use (IBN-DLO, 1999).

This process went intensively in the Ukraine, because land was accessible, interest rates were high, rural wages were low and there were opportunities for long distance trade. The low stumpage fees also contributed to the conversion of wooded lands into agricultural lands since even modest rates of return that were expected from agriculture compare favourably to forestry at low stumpage prices (cf. Kaimowitz and Angelsen, 1998). Valuable forest sites were harvested first of all, and species composition of the forest stands worsened. Consequently, the unbroken impenetrable dense forests of the Polissja and Wooded Steppe have been reduced, and forests alternated with the prevailing Steppe. Due to excessive felling age structure, density and stand productivity of the forests[42] substantially declined.

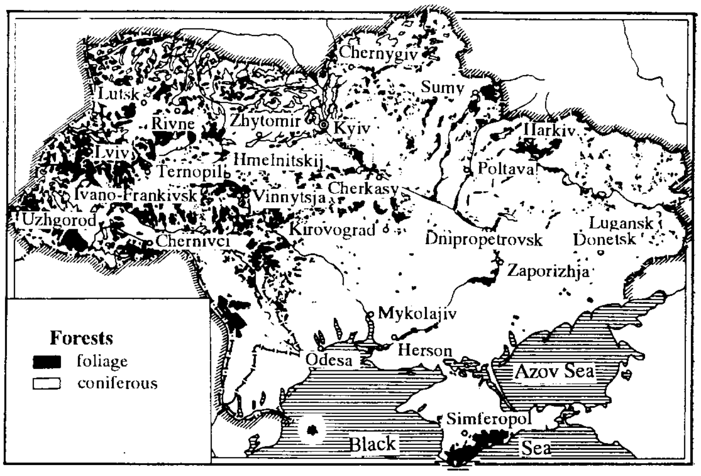


Figure 5.2. Forests in the late 20th century.
Source: Gensiruk and Nizhnik (1995)

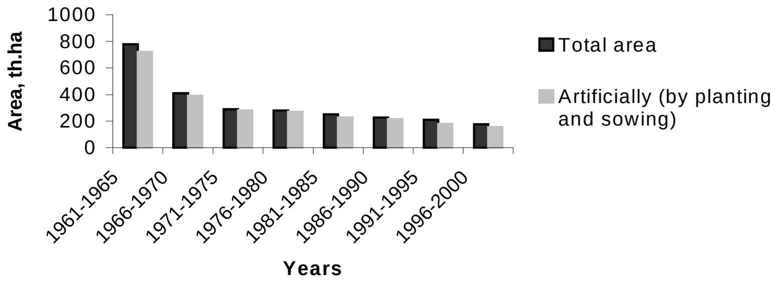
The forest share in percentage to the land area in the Ukraine comprises 15.6% (State Committee of Forestry, 2000). It is one of the lowest estimates to compare with other European countries (in France 23%, in Germany 30%, in Poland 28%, etc.). Only such countries as Ireland, Denmark, the Netherlands and the United Kingdom have lower shares of wooded area. Because forests in the Ukraine are on the frontier of the Steppe zone, gradual deforestation under these conditions could lead to the devastation of land and the expansion of the Steppe. Economic, social and environmental consequences of deforestation, therefore, could be more complicated than in any other parts of Europe.

5.2.2 Forest regeneration and afforestation

Afforestation and reforestation are traditional in the Ukraine, in view of the environment. The success has been achieved in the Steppe forest growing as far back as the 18th century. However up to the 1920s, the efforts of the foresters concerning afforestation were isolated and episodic (Gensiruk and Nizhnik, 1995). The protection of lands by means of tree-planting was considerably hampered by economic and social conditions. Great volume of silvicultural operations fell to the post-war period, when annually 70 thousand hectares of lands were planted with trees. The highest level of afforestation and forest regeneration was reached in 1951-1955. During the last 50 years, the wooded area in the Ukraine has expanded by 2.5% (Appendix 5.1). With time, however, afforestation of marginal lands has become more difficult and expensive since the lands that were more suitable for tree-planting had been already afforested. The area under reforestation and afforestation has been decreasing due to the suspension of the programme and because the area of non-forested lands has decreased (Figure 5.3).

[42] Definition of forest in the present assessment is rather broad and includes lands with a minimum crown cover of 20% (as seen on: www.fao.org, 2001).

Figure 5.3. Afforestation/Reforestation and Forest Regeneration in the Ukraine in 1960-2000



Source: State Committee of Forestry (1998 and 2001)

Later, methods of logging operations moved away from clear-cutting and were partially replaced by selective and gradual cut, further reducing the area, which required tree-planting. Recently tree-planting activities have decreased further and the share of natural regeneration after timber harvesting has risen, especially in forestry zones where the conditions are appropriate to provide natural forest renewal.

Together with afforestation and reforestation, both artificial and natural, the creation of protective wooded belts around fields, water basins, and industrial agglomerations and along roads is a recognised sustainable rural policy measure. Over 1.2 million hectares of wooded hedges, including 0.5 million hectares of wooded lands around fields, have been created in the country to prevent soil destruction and to increase land productivity. These wooded areas protect 13 million hectares of arable lands. Especially protective wooded areas are helpful in periods with extreme weather conditions when forest save the soil and the harvest.

Despite the fact that afforestation and forest regeneration are traditional policy measures that are considered in the National Programme on Land Protection for 1997-2010 (Ministry for Environmental Protection, 1998)[43], tree-planting activities in the country have been shrinking (Figure 5.3). In addition to the mentioned reasons, this is caused by difficulties of the transition period, which include: institutional weakness; an absence of well-defined and ensured system of property rights on land; a shortage of investments; an absence of economic incentives for tree-planting activities; a shift in the mentality of forest policy actors away from long-term strategies of sustainability to short-term problems e.g. rent-seeking, in conditions of high interest rates. For a sparsely wooded Ukraine that imports timber and experiences environmental problems the trend towards decreasing rates of tree-planting activities causes concern. A necessity to optimise the balance between arable and wooded lands in the Ukraine's rural planning becomes evident.

5.2.3 The objectives of the Programme

Afforestation and reforestation is to enhance a long list of forest functions, with the enlargement of timber supply and the protection of land against erosion as priorities (Table 5.1). Since economic problems in the Ukraine's forestry are discussed in Chapter

[42]Reforestation coefficient (the share of reforested areas after cutting through 5 years) stays high, 94% (SCEFORMA, 2000).

2, my purpose in this section is to substantiate afforestation programme in view of the environment, and particularly with regard to forests' contribution to soil protection.

Table 5.1. Forest Benefits[44]

Production/goods (material)	Services (non-material)
Wood: - logs - industrial roundwood - pulpwood - paper and paper board - chips and paticles - wood based panels - fuel wood - other	Environmental Regulatory: - **protection of soil** (erosion, floods) - regulation of climate: global ($CO2/O2$ exchange) and local (screening, absorption of pollutants and noise) - water regulation and purification[45] Support: - of livelihoods and habitats - biological diversity
Non-wood products: - food, as berries, mushrooms, nuts, honey, game, birch juice - medical herbs - fodder for domestic animals - materials, as wool and skins - decoration	Social Recreational functions: - leisure and tourism - hunting and fishing - landscape Information and reservoir: - a source of species and genes, - socio-cultural, spiritual, - intrinsic natural values

Source: Adapted from FAO (1992) and IAC/EC-LNV (2000) for Ukrainian forests

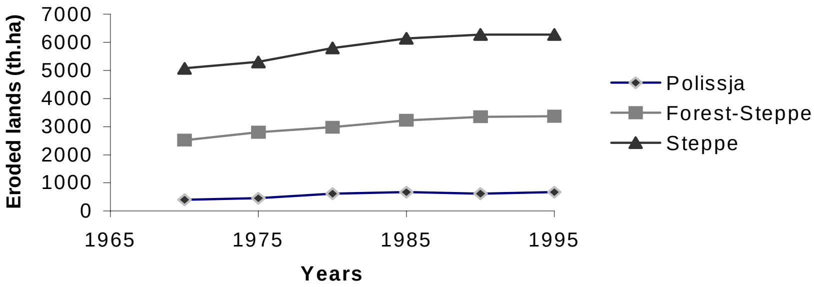
In conditions of a sparsely wooded territory and an extensive agriculture, with the high level of cultivation (54.8%)[46], the Ukraine is faced with erosion on 35% of its arable lands (National Academy of Sciences 1999). Twenty million hectares of land are under various stages of erosion, and it is expanding with time (Figure 5.4). Erosion is especially harmful in the Carpathians, where it causes windthrows and floods. Water erosion on slopes is caused mainly due to incorrect use of slopes and the loss of forest cover.[47] In the Carpathian Mountains, about 70% of agricultural lands are under erosion (60%-water and 12%-wind erosion), with 8% share of highly eroded lands (Ministry of Environment, 1993). Water erosion is also extensive on riverbanks and shores of water reservoirs, including of the Black and Azov Seas. Erosion in river basins occurs due to the destruction of watersheds and cultivation of banks of the rivers. Wind erosion is spread in the plain regions of the Steppe, in the Southern and Eastern Ukraine, where blowing away soil and sandy storms are often observed.

Erosion causes substantial economic losses. Due to erosion, on 2 million hectares of land in the Western Ukraine, average agricultural losses of crops are up to 40% (National Academy of Sciences, 1992). According to the Academy (1992), if erosion spreads further with the same intensity as now, it will cause considerable losses

[44] The indented issues are studied in-depth.
[45] See Appendix 5.2.
[46] The share of arable lands in rural landscapes of some administrative regions exceeds 90% (Gusjatin region 94%, Kizivsky 94.2%, Chortkivsky 93.8%, etc. See Gensiruk et al., 1998).
[47] Cultivation, timber harvesting, using of machinery, etc.

in productivity of 1/3 of arable lands. Annually, because of erosion, 4 million tons of fertile soil are washed out of the fields (National Academy of Sciences, 1999). Thus with the price of soil (fertilisers) 10 Hr per ton[48], annual damage to agriculture from erosion exceeds 8 M€. In addition, water erosion and floods in the Carpathians cause annual damage of about 40 M€ (Gensiruk, 1999).

Figure 5.4. Erosion for some of the forestry zones of the Ukraine



Source: National Academy of Sciences (1998)

Forests use ground water for transpiration, decrease soil humidity and prevent the spreading of erosion. Economic and environmental functions of Ukrainian forests are essential, but according to the projections of the National Academy of Sciences (1998), the share of wooded area in the Ukraine and in each forestry zone is insufficient (Appendix 5.1). In view of the role of forest in alleviating erosion[49], optimal wooded area for the country and per forestry zone was estimated at the National Academy of Sciences (Table 5.2). According to the projections, optimum wooded area in the Ukraine should be 20%, and this will prevent further spatial spreading of erosion and its intensity. To reach the optimum wooded area, afforestation is pertinent.

Table 5.2. Wooded area in the Ukraine per Forestry Zone, %[50]

Forestry Zone	Original	Present	Optimum
Polissja	72.8	26.1	37.1
Wooded Steppe	52.0	13.0	16.8
Steppe	20.0	3.5	7.7
Carpathians	76.0	40.2	50
Crimea	14.2	10.0	12
The Ukraine	44.4	15.4	20

Source: National Academy of Sciences (1998) and the State Committee of Forestry (2000)

Considering the above, a sound policy measure to approach sustainable development is to expand forest cover. Because to address all gains from afforestation is not possible within the capacity of this chapter, its scope is limited to timber supply and soil protection benefits to be received with the proposed programme.[51]

[48] In 2000, 1 hryvna corresponded to 0.2 €.

[49] It is suggested that forest starts providing protection benefits after the age of 5 years (National Academy of Sciences of the Ukraine, 1999), and with its gradual regeneration, it keeps providing protection effect for an indefinite period of time.

[50] Original wooded area stands for the beginning of the 20th century and optimum is explained in Appendix 5.1.

[51] Planting trees in the Ukraine to sequester carbon is considered in Chapter 7.

5.3. Afforestation Potential Assessment

5.3.1. Assessing area suitable for tree-planting

The proposed afforestation programme is aimed at planting forests on low-productive agricultural lands and bare lands and the creation of forest stands along rivers, canals and water bodies. It is expected that by planting trees wooded area in the Ukraine will increase by about 20%. Consequently, additional wood will be produced, and the environmental situation will improve.

The lands that fit for afforestation include:

- previously productive lands in the Wooded Steppe zone that originally were covered by forests but later on were converted into lands of other categories, including waste lands;
- marginal agricultural lands;
- certain highlands not covered with forests in the Carpathian mountains;
- eroded and contaminated areas in various regions of the Ukraine;
- lands on sands, slopes, along roads, around water basins, etc. where it is wise to create nature protected belts and keep these areas under conservation;
- zones around industrial agglomerations and lands that were used in the mining industry for storage of wastes and which today are under recultivation (Ministry of Environmental Protection, 1998):

The Comprehensive Forest Zone Classification System (Gensiruk and Nizhnik, 1995) is used as a methodological background for assessing the possibilities of enlarging forest cover in the Ukraine. The need for zoning as a basis for assessment of afforestation potential arises from the fact that forest zoning enables a precise definition of ecological aspects of tree-growing, choice of the most appropriate tree species for planting and estimation of the costs and benefits of afforestation. All these characteristics will be approximately equal within each spatial unit of forestry classification, depending on the level of hierarchy (Table 5.3).

Table 5.3 Some of Economic and Environmental Characteristics per Forestry Zone

Characteristics	Polissja	Wooded Steppe	Steppe	Carpathians	Crimea
Annual average, t^{o}C	6.9	7.2	9.0	4.7	6.0
Precipitation, mm/year	600-650	550-600	350-450	1200-1600	500-600
Wooded area, %	32.1	11.4	2.5	40.2	32.0
Harvesting, m^3/ha	1.9	2.2	0.6	3.9	0.8
Labour inputs, people/1000ha	19	22	23	12	10

Source: Gensiruk and Nizhnik (1995)

The spatial classification of forests has been developed by us as a separate study with the aim to enhance sustainability of forest resource use. The objective of the study was to improve spatial planning of forestry with respect to various forest functions and to different perceptions of forest management in different areas. The starting phase was to define borders between forestry regions of various levels, according to natural, economic and social conditions of the areas under investigation (Table 5.3). The hierarchical method of multi-criteria classification, cluster analysis (Aldenderfer and Blashfield, 1984) was applied in the study, together with the other research tools[52].

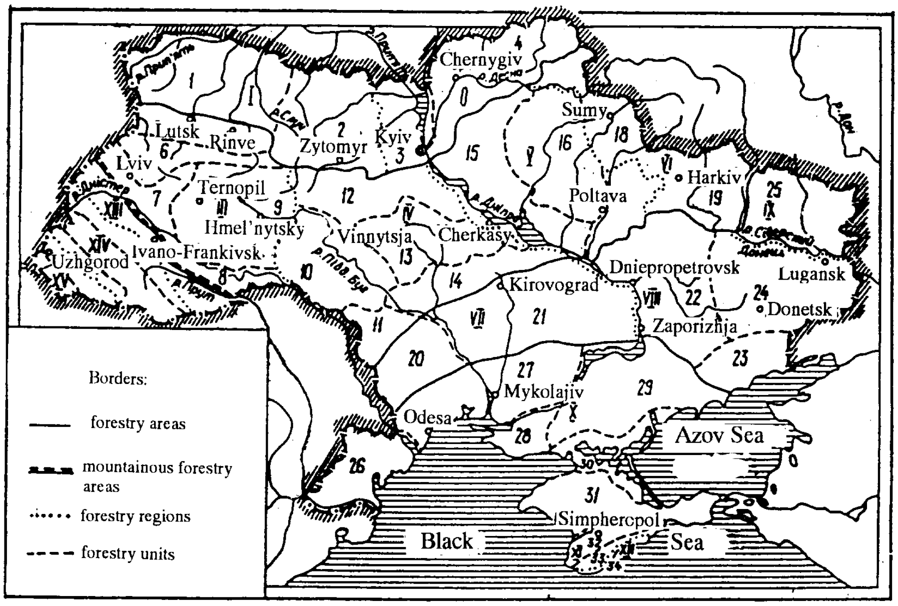


Figure 5.5.Forestry Zoning of the Ukraine. Scale: 1: 15 000 000

Forestry region: l-Western and Central Polissja (1 and 2); ll-Kyiv-Chernigiv Polissja (3 and 4); lll-Western Wooded Steppe (5, 6, 7, 8 and 9); lV-Dnister-Dnieper Wooded Steppe (10, 11, 12, 13 and 14); V-Leftbank Dnieper Wooded Steppe (15, 16 and 17); Vl-Middle-Russ Wooded Steppe (17 and 18); Vll-Rightbank Dnieper Northern Steppe (20 and 21); Vlll-Leftbank Dnieper Northern Steppe (22, 23 and 24); lX-Donetsk-Don Northern Steppe (25); X- Black-Azov Sea Southern Steppe (26, 27, 28, 29, 30 and 31); Xl-Mountain Crimea (32 and 33); Xll-Southern coast (34); Xlll-Pry-Carpathian (35); XlV-Mountain Carpathian (36, 37, 38 and 39); XV- Za-Carpathian (Transcarpathian) (40 and 41)

The territory of the Ukraine has been divided into six main forestry areas (oblast), the Polissja (Wooded Area), the Wooded Steppe, the Northern Steppe, the Southern Steppe, the Crimea and the Carpathians with their subdivision into spatial units of lower levels of hierarchy (Figure 5.5). All forestry areas (oblast) were subdivided into forestry regions (okrug), by taking into consideration landscapes development, soil distribution, climatic conditions, fauna and flora of the territories under investigation, specific forestry characteristics, zones of economic specialisation, areas under recreational use and nature conservation. Fifteen forestry regions (okrug) were defined, and there were distinguished forty-one forestry units of the lowest level of taxonomy. Each of these spatial units, called "rajon", has within its area homogeneous economic, social and environmental conditions for sustainable forestry development. The work resulted with the detailed description of the spatial subsystems of the Ukraine's forestry and with recommendations on improving forest management and its focusing towards sustainability.[53] Thus, the afforestation potential in this thesis is assessed per forestry zone.

[52] Because the project had been completed, during my work at the National Academy of Sciences of the Ukraine, before I initiated this thesis, it is not the scope of the current study. In this thesis, I use its results, the spatial classification of forests, as a basis for assessing the programme of afforestation.

[53] The recommendations have been implemented in practice on various levels of forest management in the Ukraine. The comprehensive spatial forestry classification is to be up-dated in due course to account for

Within each area of spatial classification (of the highest level of hierarchy), lands suitable for afforestation are defined. The estimations employ the data from the State Committee of Forestry (1998). According to the estimations, the total unwooded area of the State Forest Fund suitable for afforestation comprises 0.4 million ha (Table 5.4.). These bare lands have been used neither in agriculture, nor for any other purposes. They are under management of the State Committee of Forestry and hardly have an alternative option for their development than that of being converted into forests.

In addition to the unused lands of the State Forest Fund, bare and marginal agricultural lands are considered for afforestation. These are the lands that are not used at all and the opportunity costs of these lands are deemed to be zero. These are also the lands associated with forage and pasture and some marginal lands used for wheat production, where net returns associated with their current agricultural activity are low. All these lands are defined on basis of the data from the State Committee on Lands. The estimations are carried out across forestry zones. Totally 2.29 million hectares are suitable for afforestation. The afforestation potential comprises areas under management of the State Committee of Forestry and marginal agricultural lands (Table 5.4).[54]

Table 5.4. The Potential for Afforestation by Land use by Zone (1000 ha)

Zones	State Forest Fund			Agricultural lands			Totally
	ravines	sand	rocks	eroded	deflated	rocky	
Polissja	65.0	82.0	0.5	73.7	0.7	26.1	248.0
Wooded Steppe	95.0	84.0	0.6	451.6	18.3	61.0	710.5
Steppe	24.0	64.0	n.a.	669.4	40.6	137.5	935.5
Carpathians	1.6	n.a.	1.4	24.6	n.a.	143.4	171.0
Crimea	0.8	n.a.	1.8	13.1	1.8	206.8	224.3
The Ukraine	186.4	230.0	4.3	1232.4	61.4	574.8	2289.3

Source: Estimated on basis of data from the State Committee of Forestry and State Committee on Lands (1998)

The main task of tree-planting activity is to create during the shortest period of time highly productive, economically valuable and stable forest stands. In most cases mixed cultures are more productive and biologically stable. However, under marginal conditions, pure stands could grow, e.g. pure pine stands on very poor or dry soils. Taking into consideration recommendations of specialists in silviculture (Gensiruk, 1992; Shvidenko et al., 1987; State Committee of Forestry, 1998), the following main tree species are suggested for planting: pine in the Steppe and the Crimea; pine and oak in the Polissja and Wooded Steppe; and beech, fir and spruce in the Carpathians. The results of the LP model (Section 5.4)[55] advocate that, with regard to user values of forest to agriculture and forestry, monoculture plantation is the right decision, from an economic perspective.

5.3.2 Valuing afforestation costs

The computation of afforestation costs is carried out for the lands that belong to the Forest Fund and also for the marginal agricultural lands suitable for tree-planting. Since

changing economic and environmental conditions of the country that influence the development of its forest sector.

[54] Further on, after estimating NPV of afforestation, the area to be planted with trees is reduced at the account of the lands for which the opportunity costs of land appear to be comparatively high (see the following sections).

[55] The model, however, is a simple one and is not able to consider all the problems comprehensively.

the lands of the State Forest Fund have no alternative use to that of tree growing, costs of their afforestation comprise tree-planting costs and silvicultural expenses. According to the Ministry of Environment[56] (1998), the costs for creation of 1 ha of forest plantation are 1000 UAH or 200 €, and the expenses for establishment of 1 ha of forest shelterbelt are 620 UAH or 124 €. These costs include tree-planting and care and protection costs. So, the data from the Council for Studies of the Productive Forces of the Ukraine used in my analysis coincides with the estimates of the Ministry of Environment. Given that the conditions for tree-growing and sustainable forest management differ across spatial units of forestry classification, within each forestry zone, the direct tree-planting costs, and care and protection costs are deemed to be equal. These expenses are comparatively low in the Ukraine due to good forest growing conditions and because of low labour costs (Table 5.5).

Table 5.5. Afforestation Costs (€/ha)

Afforestation costs	State Committee of Forestry	Agricultural lands
1.Tree-plating costs: first year costs that depend on forestry zone	100-200	100-200
2.Care and protection costs, annual basis, depend on forestry zone	12.5-30	12.5-30
3.Opportunity costs of land, annual basis[57], in addition to the above, they depend on land use	0	7-61.5

Source: Estimated on basis of data from the Council for Studies of Productive Forces (1998)

The afforestation costs for the lands that belong to the State Forest Fund differ from the costs for the marginal agricultural lands, within the same zone. The reason is that agricultural lands have alternative options for their use. Thus, for each agricultural land, in addition to direct costs of tree-planting and silvicultural expenses, net returns associated with their current use, which constitute the lowest level of opportunity costs of afforestation, are considered (Table 5.5). The estimates on net annual returns to current wheat production are based on data on land productivity, costs of wheat production and output prices (Table 5.6).

Table 5.6. Productivity and Costs of Wheat Production

Zones	Eroded land		Deflated land	
	Yield, tons/ ha [58]	Costs, €/ha	Yield, tons/ha	Costs, €/ha
Polissja	1.6	16.3	1.3	15.3
Wooded Steppe	2.2	16.3	1.4	15.3
Steppe	3.6	16.3	2.4	15.3

Source: The Council for Studies of Productive Forces of the Ukraine (1998)

Wheat is not produced in the mountainous areas of the Ukraine. The opportunity costs per hectare of lost forage, pasture and wheat production are provided in Table 5.7.

[56] In 1994-1999, it was The Ministry of Environmental Protection and Nuclear Safety, and starting from 15.12.1999, the Ministry of Ecology and Natural Resources. Presently, the State Committee of Forestry is within its organisational structure.

[57] The opportunity costs will be higher if to consider the case that after the conversion of a marginal land into forest, the Law will not allow the transference of this forest back to agriculture in a due term.

[58] Average price of wheat is 30 €.

Table 5.7. Net Annual Returns to Current Agricultural Activities (€ per ha)

Forestry zone		Forage and pasture	Wheat production
Polissja	eroded and deflated	8.0	37.8
	rocky lands	7.8	n.a.
Wooded	eroded lands	10.0	52.1
Steppe	deflated lands	9.2	14.7
	rocky lands	8.0	n.a.
Steppe	eroded lands	20.0	61.5
	deflated lands	6.0	27.2
	rocky lands	n.a.	n.a.
Carpathians	eroded lands	7.8	0
	rocky lands	7.0	0
Crimea	eroded and rocky	7.0	0

Source: The Council for Studies of Productive Forces of the Ukraine (1998)

The households use marginal agricultural lands suitable for forage production and pasture to feed their own cattle. There is no forage production from such lands provided to the farmers. The market relations are not established properly. Since under such conditions it is impossible to evaluate the private market value of forage, the estimations are based on productivity of lands in various zones and on prices, which the Ukraine's agricultural enterprises pay for equivalent cattle feeding.

Allowing for about 100-years legally stipulated ages of timber harvesting (State Committee of Forestry, 1998), a time horizon of 100 years is considered in this section.

Table 5.8. Afforestation Costs by Forestry Zones, M€

Forestry zone	Annual Costs by Zone[59]			Present Value Costs			
	Opportunity	Planting	Care and protection	r=0%	r=2%	r=4%	r=6%
Polissja	1.4	16.1	2.0	356.3	162.7	99.5	72.7
Wooded Steppe	6.4	32.8	4.1	1084.3	486.0	290.5	207.5
Steppe	14.1	49.8	7.1	2173.3	965.0	570.2	402.7
Carpathians	0.8	7.5	0.9	177.9	80.9	49.2	43.8
Crimea	0.8	19.6	2.5	345.0	159.9	99.4	73.7
The Ukraine	23.5	125.8	16.6	4136.8	1854.5	1108.8	792.4

The costs that occur during this period are computed and converted into the present value costs at different discount rates (Table 5.8). The results of the estimations appear to be very sensitive to the discount rate. At 4% discount rate, the present value of afforestation costs is 484 €/ha on average for the country. The highest PV afforestation costs are in the Steppe zone (609.5 €/ha), and the lowest PV costs are in the Carpathians (288 €/ha), at 4% discount rate. The divergence in afforestation costs is explained by the diversity of conditions across zones.

5.3.3. Timber supply benefits with the Programme

The programme is focused on the establishing of a proper share between the arable and wooded lands in the Ukraine's rural planning. The positive effects discussed in this

[59] While annual costs of afforestation per ha come very close to the estimates of the Ministry of Environment (1998), the annual figures on afforestation expenses for the country, which are provided by the Ministry are higher than our estimates. They are in the range of 212M€ to 290 M€, likely because additional expenses are necessary for afforestation of the lands contaminated with radio-nuclides. I do not take these expenses into account.

study include direct user benefits, those of additional timber supply, and indirect user benefits obtained in agriculture as a result of soil protection function of forests, which mitigate the expansion of erosion and alleviate the devastation of arable lands.

A method of approximating a sum of monetary value for additional timber yield obtained from the newly created plantations and monetary estimates of soil protection benefits with the project comprise the model being used in our study for computing total benefits of afforestation. Regarding monetary value of timber yield changes, the traditional type model employed in the study, multiplies estimates of a physical crop change based on acreage in production, by the current price of timber (Hanley and Spash, 1993). This simplified approach implies an assumption that timber use and prices remain constant. Therefore, the estimates received by using this approach are initial approximations of the values of benefits to be obtained from additional timber supply via expanding of wooded area in the country.

The implementation of afforestation programme in its full scale would enlarge wooded area in the Ukraine by 2.29 million ha. Allowing in a long- run for a stable average annual timber cut of about 2 m^3 per ha, on its present level that corresponds to 50% of mean annual increment (MAI), some 4.6 million m^3 of additional timber could be produced, bringing annual returns of 23 M€. This volume of wood comprises roughly 30% of the Ukraine's annual timber supply.

In addition, I compute the benefits from extra timber supply per forestry zone over a 100-year period[60] and compare previously made measurement of annual returns to forestry with the sum of the estimates received according to forestry zone. Given growth functions of main tree species, estimated in Chapter 3, and allowing on this basis that, at harvest time pine in the Polissja has 250 m^3 per ha, with the stumpage value of timber 5 €/m^3 (Nilsson and Shvidenko, 1999), the returns per ha in the year of harvesting of pine stands appear to be 1250 € per ha. The returns from timber harvesting are computed respectively for another tree species (Table 5.9).

Table 5.9. Initial Estimates of the Returns from Timber Harvesting[61]

Forestry zone	Tree species	Stock of stands in 100 years, m^3/ha	Returns in the year of harvesting €/ha	PV returns €/ha, 4%	PV returns by Zone M€ 0%	2%	4%	6%
Polissja	pine	250	1250	24.75	310.0	42.8	6.1	0.9
Wooded-	pine	350	1750	34.65	612.9	84.6	12.1	1.8
Steppe	oak	350	1750	34.65	612.9	84.6	12.1	1.8
Steppe	pine	250	1250	24.75	584.7	27.7	11.6	1.7
Carpathians	beech	350	1575	31.18	134.7	18.6	2.7	0.4
	fir	400	2000	39.6	171.0	23.6	3.4	0.5
The Ukraine					2304.0	318.0	45.6	6.8

Source: Data used for calculations is from the State Committee of Forestry (1998).

In addition to per ha estimates this table presents the results of calculations made per zone. Areas that are suitable for tree-planting in each zone of the Ukraine are taken from Table 5.4. The following assumptions are made: stand composition in the Wooded

[60] This roughly corresponds to officially stipulated ages of timber harvesting in the Ukraine (State Committee of Forestry, 1998)

[61] In this study, I take into account commercial timber cut and do not consider other use of the resources, as for small local business.

Steppe comprises 50% of pine and 50% of oak trees; 50% of the Steppe area are planted with trees precisely for protection purposes; beech stands in the Carpathians are planted on 50% of the area, as are fir stands.

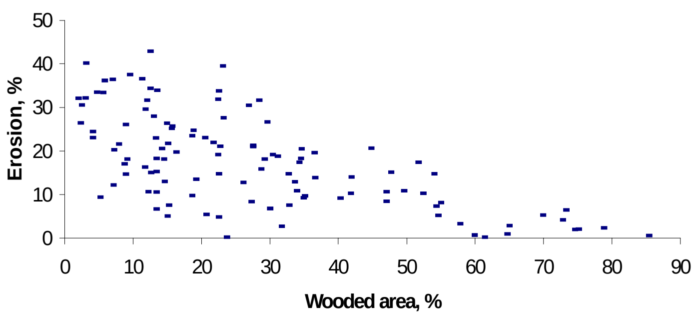
In the Crimea, which is largely a health resort and a natural reserve, plantations are to be established for environmental purposes. Thus, commercial timber harvesting here is not considered. The present value of returns from timber harvesting over a 100 year period is 2304 M€ if 0% discount rate is employed. This figure is comparable with the annual returns of 23 M€ computed earlier. The PV returns from timber harvesting depend on the discount rate employed in calculations and differ by zones. The highest benefits are to be received in the Wooded Steppe.

5.3.4. Soil protection values with the Programme

The expansion of wooded area, in addition to the above benefits with regard to timber production, will lead to increasing indirect user values of forests. Being the focus of this section, the soil protection role of forest plantations to agriculture is discussed in details. Economic attractiveness of planting trees to mitigate erosion is assessed, and the estimates obtained in this section are compared with the figures put forward by another authors (Iljev and Gordienko, 1980; Gensiruk and Ivanytsky, 1999). Numerous observations by Ukrainian scientists have indicated that forest depletion and soil erosion are closely related phenomena (National Academy of Sciences, 1999).

The proposition that the scale of erosion depends on the share of wooded lands in the Ukraine is put to an empirical test in a regression analysis (Figure 5.6).

Figure 5.6. Relation: Wooded Area-Erosion



It would be definitely better to include in the analysis also other factors that affect soil erosion, such as precipitation, soil type and spatial indicators of wooded cover, though the data was not available. Thus as the first approximation, I examine the relation between the share of forest cover and the share of erosion in rural landscapes. To perform the empirical analysis, I use the data of Gensiruk et al. (1998) on 111 observations, spatial units of the Ukraine. Erosion is considered a dependent variable, while forest cover is seen as an independent variable (Appendix 5.3).

Different functional forms are analysed, and the best statistical and theoretical fit is achieved by using the following equations. The results of the estimations show statistically significant (at 1% significance level) negative relationship between the share of eroded lands (E, %) and the share of wooded lands (W, %) in rural areas of the Ukraine:

$log(E) = 3.4653 - 0.0329*W;$ or $E = 31.986e^{-0.0329W}$, $R^2 = 0.45$

(29.13) (-9.38)

The t-statistic of -9.38 tells us that the negative coefficient on W is significantly different from 0, and with the increase of forest cover, the erosion rates decrease.

In addition, the relation between wooded lands and erosion is analysed per forestry zone. The results of the regression analysis show that in the area, which is most sensitive for water erosion, in the Carpathians, forest cover plays even a more important role in the prevention of erosion:

$log(E) = 4.3702 - 0.0523*W;$ *or* $E = 79.059e^{-0.0523W}$, $R^2 = 0.50$

(5.46) (-3.99)

Overall, erosion appears to be dependent on wooded cover. The value of R^2 allows us to advocate that there is a room for the improvement of the model. Simulated rates of erosion are shown in Table 5.10.

Table 5.10 Simulated Rates of Erosion

Wooded area (W), %	Erosion (E), the Ukraine, %	Erosion (E), the Carpathians, %	Elasticity[62], the Ukraine, %	Elasticity, the Carpathians, %
0	32.0	79.1	-1.05	-4.13
5	27.1	60.9	-0.89	-3.18
10	23.0	46.9	-0.76	-2.45
15	19.5	36.1	-0.64	-1.89
20	16.6	27.8	-0.54	-1.45
25	14.1	21.4	-0.46	-1.12
30	11.9	16.5	-0.39	-0.86
35	10.1	12.7	-0.33	-0.66
40	8.6	9.8	-0.28	-0.51
45	7.3	7.5	-0.23	-0.39
50	6.2	5.8	-0.20	-0.30
55	5.2	4.4	-0.17	-0.23
60	4.4	3.4	-0.15	-0.18
65	3.8	2.6	-0.12	-0.14
70	3.2	2.0	-0.11	-0.11
75	2.7	1.6	-0.09	-0.08
80	2.3	1.2	-0.08	-0.06
85	2.0	0.9	-0.06	-0.05
90	1.7	0.7	-0.05	-0.04
95	1.4	0.5	-0.05	-0.03
100	1.2	0.4	-0.04	-0.02

The defined from the equations ratios of marginal changes in erosion rates to marginal changes in wooded cover rates are as follows: for the Ukraine, $dE/dW=-0.0329E$, and for the Carpathians $dE/dW=-0.0523E$. These estimations show the elasticity of erosion with respect to wooded cover in the Ukraine and in the Carpathians. Until wooded cover is up to 27% in the Carpathains, and only when wooded cover in the Ukraine is very low, erosion is elastic. That means that when wooded cover is

[62] $\Delta E/\Delta W=\varepsilon\%$, 1% increase in W leads to ε % decrease in E. The figures on W and E are already given in percentage, thus it is not a straight forward computation of elasticity.

increasing marginally, erosion is reduced proportionally as much. This is observed, when the share of eroded lands is around 30% in the Ukraine, and as far as it falls below 19% in the Carpathians. With further expansion of wooded cover, and consequently with further decreasing rates of erosion, it becomes inelastic. The regression suggests that if there were no woods in rural landscapes, the share of eroded lands would comprise 79% in the Carpathians and 32% on average for the Ukraine. However, even if all rural areas in the Ukraine were covered with forests, marginal erosion would exist anyway.

Using the results of the regression analysis on the elasticities of erosion with respect to forest cover, I compute initial average indicative estimates of soil protection role of forests per zone. The reasoning behind my estimations are as follows. In the Polissja where wooded cover comprises 26% (Table 5.2 and Appendix 5.1), the elasticity of erosion is -0.43% (Table 5.10). This means that 1% increase in wooded cover leads to 0.43% decrease in the erosion rates. In the Polissja, 1% increase of forest cover and that is an increase of 0.029 Mha, will mitigate erosion on 0.2 Mha of lands in rural areas. The last figure is computed, as follows. Currently, erosion is spread on 13% of lands, or on 1.43 Mha. The decrease of erosion by 0.43% involves the area of 0.006 Mha. Therefore, the 0.029 Mha expansion of forest cover mitigates erosion on 0.006 Mha of land. Hence, 1 ha of additional forest protects from erosion 0.2 ha of land. The net annual returns from 0.2 ha of agricultural land calculated on basis of data from Table 5.7, are about 1.6 € for the land used for forage and pasture, and 7.6 € for the land used for wheat production. These figures are indicative measures of soil protection benefits to agriculture from marginal expansion of forest cover in the Polissja.

Similar estimations are made for the other forestry zones. The general formula for calculations is as follows:

$$X = \varepsilon \cdot E/W$$

where

ε elasticity of erosion with respect to forest cover, % (Table 5.10);

W share of wooded lands in rural landscapes, %;

E share of eroded agricultural lands, %;

Soil protection benefits to agriculture in the mountainous areas of the Carpathians and the Crimea appear to be rather low. The reason is that there is no wheat production here, and pastures are not common in the Crimea, because of comparatively low level of precipitation. Though according to our calculations, in the Carpathians, soil protection benefits to agriculture appear to be not really high, in addition to the increasing returns in agriculture, by means of the mitigation of erosion, mountain forests provide essential environmental effect (National Academy of Sciences of the Ukraine, 1999). Their hydrological function is significant. Annually, their prevention of waterfalls, floods and avalanches in the Carpathians offers up to 90 €/ha of non-marketed gains (Gensiruk and Ivanytsky, 1999).

In the Steppe where forest cover comprises 3.5%[63], it appears that 1 ha of wooded land mitigates erosion on 7.5 ha of lands. Continual observations by Ukrainian specialists confirm that 1 ha of wooded land enlarges yield on the area of up to 25-30 ha (National Academy of Sciences of the Ukraine, 1999). Forest has a great spatial

[63] Together with the share of wooded cover, spatial distribution of fields and woods in rural landscapes plays important role in erosion mitigation, particularly in low-forested areas. Spatial sequencing of fields and forest shelter belts in rural areas is to be investigated further.

influence on the erosion rates in the Steppe zone. However, this impact decreases with greater distance between the forest and the agricultural land it protects. On average, gains in productivity are up to 15-20%, as compared with shelterless fields (Ministry of Environment, 1998). These considerations are incorporated in calculations. The acreage of lands that are suitable for afforestation in each zone is taken from Table 5.4. An assumption is made that in non-mountainous forestry zones, 30% of agricultural lands are used for wheat production.

Table 5.11. Indicative Measures of Soil Protection Benefits to Agriculture

Forestry zone	Annual average benefits, €/ha		Annual benefits
	Wheat	Forage/pasture	M€/zone
Polissja	7.6	1.6	0.8
Wooded Steppe	33.0	9.0	11.5
Steppe	58.2	17.0	27.5
Carpathians[64]	0	9.7	1.7
Crimea	0	12.2	2.7
The Ukraine			44.2

The estimates presented in Table 5.11 are comparable with the figures provided by the other authors. According to Gensiruk and Ivanytsky (1999), annual soil protection benefits of forest for prevention of sandy storms are up to 86-93 €/ha. An expansion of forest cover by 1 ha enables to receive from one ha of the protected field net annual income of around 25 €, and from the protected pasture, 7 € (Iljev and Gordienko, 1980)[65]. A limited number of studies dealing with erosion prevention were carried out for the other countries, such as Java, the Philippines, and Malaysia. Conversion of forest to row crops increases erosion by a factor of 20 to 1000 times, depending on the conditions (Van Kooten, 1993),[66] while the protection function of forest to alleviate erosion is argued to be around 30 USD per ha (Lampietti and Dixon, 1995).

The results of the current analysis indicate empirically the dependence of erosion expansion from the share of wooded lands and propose economic estimates of soil protection function of Ukrainian forests to agriculture. According to our estimations, annually, 1 ha of forest provides soil protection benefits to agriculture in the range of 1.6 € to 58.2 €, and 19.3 € on average for the country. The soil protection benefits of afforestation to agriculture are the highest in the Steppe zone.

5.3.5. Economic evaluation of the Programme

The analysis of the afforestation programme is carried out on various levels of hierarchy. In this section, the programme is analysed for the country and across forestry zones (over the period of 100 years, at discount rates 0-6%). In Section 5.4, the analysis proceeds in detail, by taking into account various land users, tree species and three management regimes (the discount setting is 4%). The cost-benefit analysis of the programme is carried out, by taking as a criterion of the project evaluation the net present value of afforestation. The NPV determines the present value of net benefits by discounting the stream of benefits (*B*) and costs (*C*) back to the beginning of the base year $t=0$:

[64] The figures are relatively low, because these are the benefits that accrue only to agriculture.
[65] The estimates were initially given in rubbles and are transferred in €.
[66] 1000 stands for tropics

$$NPV=\sum_{t=0}^{n} B_t/(1+r)^t - \sum_{t=0}^{n} C_t/(1+r)^t$$

An important problem is to set time horizon for the programme evaluation. Benefits from afforesation are expected to accrue over a very long period, and the time of 100 years is chosen to capture most of the benefits and costs. (Table 5.12).

Table 5.12. Economic Evaluation of Afforestation Programme over the Period of 100 Years at Different Discount Rates, M€

Forestry zone	r %	PV timber benefits	PV erosion benefits	PV total benefits	PV costs	NPV
Polissja	0	310	84	394	356.3	37.7
	2	42.8	36.2	79	162.7	-83.7
	4	6.1	20.6	26.7	99.5	-72.8
	6	0.9	13	13.9	72.7	-58.8
Wooded Steppe	0	1125.8	1150	2275.8	1084.3	1191.5
	2	169.2	495.6	664.8	486	178.8
	4	24.2	281.8	306	290.5	15.5
	6	3.6	177.8	181.4	207.5	-26.1
Steppe	0	584.7	2750	3334.7	2173.3	1161.4
	2	27.7	1185.2	1212.9	965	247.9
	4	11.6	673.9	685.5	570.2	115.3
	6	1.7	425.2	426.9	402.7	24.2
Carpathians	0	305.7	170	475.7	177.9	297.8
	2	42.2	73.3	115.5	80.9	34.6
	4	6.1	41.7	47.8	49.2	-1.4
	6	0.9	26.3	27.2	43.8	-16.6
Crimea	0	0	270	270	345	-75
	2	0	116.4	116.4	159.9	-43.5
	4	0	66.2	66.2	99.4	-33.2
	6	0	41.8	41.8	73.7	-31.9
Ukraine	0	2303.6	4424	6727.6	4136.8	2590.8
	2	318.1	1906.7	2224.8	1854.5	370.3
	4	45.6	1084.1	1129.7	1108.8	20.9
	6	6.8	684.1	690.9	792.4	-101.5

The study outcome suggests that planting trees in the country and the establishment of proper share of wooded and cultivated areas will contribute to timber supply and to the prevention of erosion, providing substantial benefits also to agriculture. The present value estimates of soil protection role of forest appear to be high in the Ukraine. The results of cost-benefit analysis depend on the discount rate. The net present value of the programme on average for the country is positive for the discount rates of 0%-4%, when its benefit/cost ratio is higher than 1. At these discount rates, the programme enlarges social benefits to the Ukraine's agriculture and forestry and adds to the welfare of the society.

The observation across forestry zones gives more precise results. The general conclusion is that even if to limit benefits to timber supply gains and additional indirect user values of the project to agriculture, these benefits will already cover the costs of afforestation at 0% and 2% in the majority of the zones. The best results are achieved for the Steppe and Wooded Steppe, while in the Polissja and the Crimea for the discount rate of 2% the establishment of forest plantations is not rational. The investigation across forestry zones provides the following results: the area to be planted with trees is to be 2.07 Mha for the discount rate of 0% (excluding the Crimea); it is to be 1.82 Mha for the discount rate of 2% (excluding the Crimea and the Polissja); it is to be 1.65 Mha for the discount rate of 4% (excluding the Crimea, the Polissja and the Carpathians); and its is to be 0.94 Mha for the discount rate of 6% (with the establishment of forest plantations only in the Steppe).

In the Carpathians and in the Crimea commercial timber harvesting is restricted. Thus, the benefits from the extended timber supply from the newly created plantations are not that high in the Carpathian Mountains and are not considered at all in the Crimea. Agricultural production is also limited in the mountainous areas and, therefore, the benefits that accrue to agriculture from soil protection forest function are moderate. Consequently, NPV of the programme is relatively low in the Crimea and not that high in the Carpathian Mountains

In addition to the discussed above forest values to agriculture and forestry, the afforestation programme will contribute to managing sustainability via offering other forest functions (Table 5.1). These gains will include the use of forests for recreation[67] and their role in global carbon budget, which is the focus of the following chapter. The non-user forest values such as biodiversity are high in the Ukraine, especially in the mountains (Ministry of Environment, 1998). The incorporation of these forest values in the analysis will enlarge PV total benefits from afforestation and will provide higher NPV of the programme.

The cost-benefit analysis considers afforestation programme for the country and across its zones at various discount rates, though, without judging which exactly lands (bare, marginal agricultural lands currently used for forage/pasture or used for wheat production) is reasonable to convert into wooded areas or which management regime is preferable. A more detailed decision-support tool is proposed in the following section.

5.4. An LP Model for the Projected Forest Plantations

5.4.1. Analytical framework and description of parameters

In cases, when it is impossible to specify precisely the production function that relates inputs and outputs of forest management and when inputs and outputs are to be considered together, the best solution is to employ linear programming. Constrained optimisation technique allows to explore technical and economic dimensions of input and output selection simultaneously and to account for sustainability in forest resource management and planning. The application of LP for analysing sustainable forest resource management is usually done by maximising economic benefits of timber production while accounting for preservation of environmental quality and productivity of forests (Hof, 1993; Buongiorno and Gilless, 1986).

The general idea of the model discussed in this section is to provide guidelines for the establishment and management of future forests in a way that allows achieving maximum cumulative net present value of benefits from them over the period of timber rotation subject to the constraints. The model is a manageable and is to serve a scheme for decision support system that addresses the production side of the Ukraine's forestry. The discount rate employed in this analysis is 4%.

[67] This was the topic of earlier studies. See, for instance, the book of Nijnik, M. (1989) Forest Management and Recreation, Kiev, Ukraine.

The model considers bare and marginal agricultural lands suitable for afforestation in all forestry zones, with the exception of the Crimea. The timber production benefits from newly planted forests and soil protection forest functions are taken into consideration. Theoretical representation of the model presumes that the production function is multi-input and multi-output. The land and management regimes across forestry zones are inputs to the production system. The input of land comprises bare lands and marginal agricultural lands, such as pastures and the lands presently used for forage and wheat production. Thus, trees can be planted on bare lands for which the opportunity costs of afforestation are deemed to be zero. Then, the area of forests may include the lands that are presently used as pastures and for forage production. Further on, it might be also reasonable to create forests on marginal agricultural lands that are used for wheat production. These lands currently provide positive net returns associated with their agricultural activity. However, these returns might be insufficient and allow the conversion of the lands into forest plantations.

The analysed management scenarios allow for different species composition of the projected forests. Pine and oak are main tree species grown in the Wooded Steppe and the Polissja. Pine is considered for planting in the Steppe, and fir and beech, in the Carpathians. In addition to species composition, three forest management regimes are considered.

The first regime is a basic silviculture (m_1), with officially accepted in the Ukraine ages of timber harvesting (State Committee of Forestry, 1998). The regime is based on quick replanting of the desired tree species after harvesting that is often followed by brushing and weeding of tree stands. It is largely used in the USA and Canada. The reason for preferring a basic policy, e.g. in Canada, lies in the objective of forest companies to achieve quick full stocking and to maximise volume of stands rather than to receive high quality wood (Wang and Van Kooten, 2001). The financial attractiveness of basic policy and the opinion that due to uncertainty it is reasonable to limit investment in incremental forest management allow me to consider a basic regime among the alternatives. The option is also supported by the view that there are only two prospects for value adding stand management in addition to basic silviculture, i.e. fertilisation and genetic improvements (Binkley, 1997).[68]

The second forest management regime (m_2) chosen for analysis is that of planting trees and then attending all silvicultural operations that are prescribed by the rules of the Ukraine's forest legislation. The rotation ages are the same as under the first management regime. Currently, the Ukraine's forest law recommends harvesting of pine stands in 90 years, fir in 90-100 years, and oak and beech stands at 100 years of age. Before main cut, felling operations connected with silviculture take place. In the Ukraine, they are called improvement fellings. Depending on the age of stands, they comprise activities, which are now specified in this text. Clarification and cleaning are carried out in stands of up to 10 and 20 years old, respectively. Thinning is carried out at the age of up to 40 years. Increment felling is the last felling operation that is performed in Ukrainian forests one age class before the main felling. This regime is comparable with incremental silviculture in Canada that refers to stand tending treatments, such as conifer release, juvenile spacing, pruning, fertilising and commercial thinning (Wang and Van Kooten, 2001). All these activities are undertaken to maintain a desired species composition of forests, to accelerate tree growth, increase timber yield

[68] Due to the shortage of investments a broad-scale fertilisation and genetic improvements are not imminent for Ukrainian forestry.

and improve the quality of wood. According to the evidence provided by Ukrainian specialists, incremental forest management increases total productivity of forest stands by 5-10%, and of oak stands up to 16% (Gensiruk, 1992).

The third management regime (m_3) considers basic silviculture with the rotation period of timber that corresponds to MSY. Timber harvesting takes place as forest stands reach maximum of mean annual increment. In Chapter 3, I compute the MSY rotation ages for each tree species according to zone (65-70 years). Designed to attend to the management of forests that consist of different species projected for planting in different zones, the model presumes quantitative assessment of the perspectives for sustained use of forest resources, as is seen today in the Ukraine[69].

Sustainability is addressed within the modelling process through testing the MSY timber rotation scheme for basic silviculture that is largely accepted among market-oriented forest practitioners. Allowing for sustainability, the model deals with multi-functional use of the plantations and, as mentioned above, together with timber supply it accounts for soil protection forest function. Thus, the output set of the model comprises a marketed commodity, timber, and soil protection benefits of the forests, for which the values are imputed from the calculations made in the previous section.

The model provides guidelines for the establishment of future forests in a way that allows, over a specified period of timber rotation, to achieve maximum cumulative net present value of timber and soil protection benefits from the forests subject to the constraints. Though this simple model concerns comparative static decision-making, given the alternatives, it assists in assessing the areas to be planted with trees, to clarify species chosen for planting, and by analysing the scenarios, to distinguish a basis for cost-efficient sustainable forest policy decisions.

A mathematical framework of the LP model is as follows:

$$Max\left\{\sum_{zatm} X_{zatm} \cdot O_{zatm} \cdot P_{at} + \sum_{zatm} B_{zatm} \cdot X_{zatm} - \sum_{zatm} X_{zatm} \cdot C_{zatm}\right\}$$

where

z = 1, 2, 3 and 4	forestry zones (1 - the Polissja; 2 - the Wooded Steppe; 3 - the Steppe; 4 - the Carpathians);
a = 1,2, and 3	types of land (1 - bare; 2 - pastures and used for forage; 3 - used for wheat production);
t = 1,2, 3 and 4	tree species (1 - pine; 2 - oak; 3 - beech; 4 - fir);
m	management regimes (m_1, m_2 and m_3) presented above;
X_{zatm}	the hectares of land "a" allocated in the zone "z", to be planted with "t" species scenario when management regime "m" is applied;
O_{zatm}	timber output per ha of "z" zone of land "a" planted with tree species "t" and treated with management regime "m", m^3/ha;
P_{at}	the discounted stumpage price of 1 m^3 of timber of tree species "t" grown on the type of land "a", €/m^3;

69 As it is elucidated in Chapter 3, the idea of MSY differs substantially from the concept of weak sustainability that is pertinent for the forestry-in-transition.

B_{zatm}	the discounted soil protection benefits of 1 ha of forest planted in the zone "z" on the land "a" with tree species "t" and treated with management regime "m", €/ha;
C_{zatm}	the discounted costs per ha during the rotation period in the zone "z" on the land "a" planted with tree species "t" and treated with the management regime "m", €/ha. The costs include direct tree-planting costs, care and protection costs, the costs of timber harvesting and the opportunity costs of land.

The figures in "timber" and "soil protection" rows in Table 5.13 stand for the resource flows per hectare, which result from applying the chosen management regime on the land X_{111m1} through X_{434m3}. For instance, O_{111m1} is the output of timber m^3 per hectare of bare land in the Polissja to be planted with pine stands when the first management regime is to be applied.

Table 5.13. An Input Matrix of LP for Multiple Forest Use in the Ukraine

Z=	a=	bare lands (b)			pastures (p)			wheat lands (wh)		
POLISSJA	m=	m1	m2	m3	m1	m2	m3	m1	m2	m3
m3/ha	Pine (p)	463	509.3	283	594.6	654.1	592	594.6	654.1	592
m3/ha	Oak (o)	237	260.7	145	397	436.7	263	481.7	529.8	272
Pp (€/m3)	Prices(p)	0.17	0.17	0.43	0.17	0.17	0.43	0.17	0.17	0.43
Po (€/m3)	Prices(o)	0.30	0.30	0.76	0.30	0.30	0.76	0.30	0.30	0.76
Bp(€/ha)	Soil	29.1	29.1	27.7	29.1	29.1	27.7	184.4	184.4	175.5
Bo(€/ha)	Soil	29.4	29.4	27.7	29.4	29.4	27.7	186.2	186.2	175.5
Cp (€/ha)	Costs (p)	336.8	663.8	429.4	598.2	932	1091.4	889.4	1223.2	1368
Co (€/ha)	Costs (o)	251.2	657.7	327.7	575.7	990.3	719	861.7	1280.6	961.7
Wooded	a=	bare lands (b)			pastures (p)			wheat lands (wh)		
Steppe	m=	m1	m2	m3	m1	m2	m3	m1	m2	m3
m3/ha	pine (p)	354	389.4	272	594.6	654.1	592	594.6	654.1	592
m3/ha	oak (o)	233	256.3	145	397	436.7	263	481.7	529.8	272
Pp (€/m3)	prices(p)	0.17	0.17	0.43	0.17	0.17	0.43	0.17	0.17	0.43
Po (E/m3)	prices(o)	0.30	0.30	0.76	0.30	0.30	0.76	0.30	0.30	0.76
Bp (€/ha)	soil	218.4	218.4	207.4	218.4	218.4	207.4	800.8	800.8	760.5
Bo (€/ha)	soil	220.5	220.5	207.4	220.5	220.5	207.4	808.7	808.7	760.5
Cp (€/ha)	costs (p)	298.0	671.0	487.8	615.2	1000.5	1108.4	1634.4	2019.8	2076.4
Co (€/ha)	costs (o)	249.2	655.4	327.7	575.7	990.3	719	1589.7	2008.6	1913.5
Steppe	a=	bare lands (b)			pastures (p)			wheat lands (wh)		
	m=	m1	m2	m3	m1	m2	m3	m1	m2	m3
m3/ha	pine (p)	136	149.6	150.3	211.7	232.9	174.1	211.7	232.9	174.1
Pp (€/m3)	prices(p)	0.17	0.17	0.35	0.17	0.17	0.35	0.17	0.17	0.35
Bp (€/ha)	soil	412.5	412.5	397.7	412.5	412.5	397.7	1412.4	1412.4	1361.6
Cp (€/ha)	costs(p)	194.5	1111.2	224.5	657.9	1578.8	729.5	2417.3	3338.2	2425.6
Carpathi-ans	a=	bare lands (b)			pastures (p)					
	m=	m1	m2	m3	m1	m2	m3			
m3/ha	fir (f)	524	576.4	387	415	456.5	285			
m3/ha	beech (b)	421	463.1	317						
Pf (€/m3)	prices(f)	0.11	0.11	0.35	0.11	0.11	0.35			
Pb (€/m3)	prices(b)	0.20	0.20	0.62						
Bf,b(€/ha)	soil	237.7	237.7	226.9	237.7	237.7	226.9			
Cf (€/ha)	costs(f)	298	674.5	550.6	451.5	900	618.8			
Cb(€/ha)	costs(b)	262.4	1137.1	472.2						

Source: Self estimates on basis of data from the State Committee of Forestry (1998), State Committee on Lands (1998) and Shvidenko et al. (1987).

The "outputs" of soil protection benefits of 1 ha of forest to mitigate the erosion are presented already in monetary terms. They are the discounted benefits B_{zatm}, €/ha that are estimated in Section 5.3. For instance, B_{111m1} stands for the discounted soil protection benefits from planting of 1 ha of pine forest on bare lands of the Polissja when the first management regime is applied.

The discounted prices P_{at} of one m^3 of wood are provided in the "prices" row. For instance, P_{bp} is the discounted price of one m^3 of timber produced from pine plantations established on bare lands.

The coefficients in the "costs" row in Table 5.13 define the cost of applying one or another management regime on one hectare of forest land. For example, C_{111m1} are the discounted costs per ha of pine forest created on bare lands of the Polissja and treated with the management regime m_1.[70]

The lands suitable for afforestation in each of the zones and in the country in general have their upper limits. The objective function, therefore, is maximised subject to the following acreage constraint:

$$\sum_{tm} X_{zatm} \leq F_{za} \forall z, a$$

where F_{za} is total area in the zone "z" of the user "a".

The data on lands suitable for the establishing forest plantations is provided in Table 5.14.

Table 5.14. The Lands Suitable for Afforestation by Zone, Mha

Zones (z=)	Lands (a=)	Area (Fza=)	Area by zone (F=)
Polissja (w)	bare/b	0.12	
	pastures/pa	0.06	
	wheat/wh	0.07	0.25
Wooded	bare/b	0.28	
Steppe (w-s)	pastures/pa	0.37	
	wheat/wh	0.06	0.71
Steppe (s)	bare/b	0.13	
	pastures/pa	0.14	
	wheat/wh	0.67	0.94
Capathians (c)	bare/b	0.01	
	pastures/pa	0.16	0.17
The Ukraine			2.07

Source: Computed on basis of data from the State Committee of Forestry and State Committee on Lands (1998)

$$X_{1a3m} = 0 \forall a, m$$

$$X_{1a4m} = 0 \forall a, m$$

$$X_{2a3m} = 0 \forall a, m$$

$$X_{2a4m} = 0 \forall a, m$$

$$X_{3a2m} = 0 \forall a, m$$

$$X_{3a3m} = 0 \forall a, m$$

[70] The forest growing conditions of pine and oak stands in the Wooded Steppe and the Polissja are assumed to be similar.

$X_{3a4m} = 0 \forall a, m$

$X_{4a1m} = 0 \forall a, m$

$X_{4a2m} = 0 \forall a, m$

The above constraints imply that only main tree species "t" chosen for planting are to be planted across zones "a", whatever management regime "m" is applied.

$X_{424m} = 0 \forall m$

$X_{43tm} = 0 \forall t, m$

The last two constraints mean that in the Carpathian Mountains, beech forests do not grow on high altitudes, where main pastures are located, and that there are no lands suitable for wheat production in the mountains.

The software used to run the model is Visual Xpress, for the programme see Appendix 5.4.

5.4.2. Results

The results provide evidence that under the assumptions that have been considered, and for a discount rate of 4%, it appears to be reasonable to plant trees only on bare lands allocated for afforestation in the Wooded Steppe, Steppe and the Carpathians. The total area to be converted in forest is 0.42 Mha. (Table 5.15).

Table 5.15. The Programme of Afforestation: Outcome of the Model, 4% discount rate

Forestry zone(z)	Lands (a)	Area to be planted with trees (Fza), Mha	Tree species (t)	Management regime (m)	Shadow prices €/ha
Wooded Steppe	bare	0.28	oak	basic m_1	41.2
Steppe	bare	0.13	pine	basic m_1	245.2
Carpathians	bare	0.01	beech	basic m_1	59.5

The dual-primal property of LP problem is one of its useful features, because it yields shadow prices for the constraints. A shadow price indicates how much the value of the objective function changes if the constraint is changed by one unit. This is very important for sustainable management of forests when shadow prices often take the place of actual market prices as guides to the evaluation of non-marketable environmental services. The shadow prices of land appear to be the highest in the Steppe. Overall, it appears to be more efficient to establish monoculture forest plantations. This result could be largely explained by the fact that in the model I account only for user values of the plantations. Regarding management regimes, in all forestry zones, basic silviculture proves to be more rational.

Concerning the rotation period, the model does not allow for really good comparison of different ages of timber harvesting. The reason is that the period of time chosen for investigation is too short. Much better results could be obtained with the expansion of the period and when several timber rotations are observed. Then, harvesting at the ages of maximum sustainable yield (m_3) or even shorter could appear to be more economically efficient than under the options when timber is harvested when it is officially prescribed in the Ukraine, at ages of trees around 100 years (m_1 and m_2 scenarios). This is because, with shorter rotation ages, as under the third management regime, more revenue flows will occur over a longer period. In 140 years, for instance, under the first and the second management regimes profits will be received only once, while under the third management regime they will be obtained already twice. The model that considers a period of one time timber rotation does not allow seeing that.

5.5. Afforestation Programme: Managerial Perceptions

The programme has been assessed in its first approximation by using a static modelling approach and making an assumption that it could be implemented all at once, without taking into account its temporal and spatial sequencing. Though we do not expect that a dynamic approach will change study outcomes substantially, it has to be done in the future, with regard to policy-making objectives. Currently, reforestation and afforestation are under execution and control of the State Committee of Forestry (previously, the Ministry of Forestry), and silviculture is a monopoly of the state. The weaknesses of command-and-control mechanism of implementation of the afforestation programme include the lack of diversity and experimentation, the absence of flexibility and economic incentives for providing tree-planting. However, control mechanism is justified on efficiency grounds if savings in transaction costs exceed the gains from using another co-ordination mechanisms, or if there are economies of scale and scope that would not be realised otherwise (Van Kooten et al, 2001). This implies to external benefits, such as erosion prevention. An important issue related to practical implementation of the programme is a discrepancy in distribution of benefits and costs from afforestation. Certain lands that are to be converted into forests currently are used in agriculture. The establishment of forest plantations is to be executed in the forestry sector, while the soil protection benefits accrue to agriculture. The problem "who pays and who receives the benefits" that can not be solved through the market is to be settled by the government. To implement the programme, Ukrainian authorities have to use the production capacities of the state forest enterprises. In addition, they could consider the option to give certain lands suitable for tree-planting to the farmers and co-operatives. Concurrently with the lands, the farmers are to be given subsidies, which enable them to initiate and carry out tree-planting activities. This will intensify the process of afforestation only in conditions of appropriate level of subsidies, which provide economic incentives to the farmers to plant trees on their lands.

Today, under the existing system of forest management, only the forest enterprises are in charge of planting trees in the Ukraine. They receive government investments to fulfil this task, while their activities are controlled by the state. Weak feature of the existing structure of silvicultural management is that because the forest enterprises receive money from the state, they focus on budget maximisation from centralised funding rather than on their production goals. The market is not functioning properly, and without profit maximising objectives and production-oriented goals, the forest enterprises have no incentives to growing trees and to producing valuable stands. This practice could hamper the implementation of the afforestation strategy. If the production is financed by the capture from timber and non-timber forest benefits the process of forest renewal would be economically justified. In order to motivate a tree-planting process within the system of timber production, the stumpage fees are to become higher, and the share of earnings from timber selling has to reside within the forest enterprises. That is not the case nowadays (Krott et al., 2000).

Despite that afforestation costs, especially for the wastelands, are low, and there are external benefits from tree-planting, e.g. the effects of alleviating erosion, a large-scale implementation of the programme will not take place without government subsidies or foreign investments. This is because the afforestation costs, being low, still are higher than the value of forested land. The conclusion is that the afforestation programme is to be implemented as an administrative sustainable forest policy measure, because of its external benefits and since the present managerial setting, with the absence of economic incentives for tree-planting and growing, make the programme non-viable without centralised management and funding.

5.6. Conclusions

The proposed programme is seen as a means to realise sustainability in the Ukraine's forestry and in its rural economy. For the excessively ploughed and sparsely wooded country, the expansion of its forest cover is an important sustainable rural policy measure. 2.29 million hectares of lands are defined suitable for tree-planting. The costs of afforestation, particularly direct tree-planting costs, are low in the country due to good forest growing conditions and low labour costs. Total benefits of afforestation considered in this chapter include the timber production and soil protection benefits of forests to agriculture. Annually, 1 ha of forest in the Ukraine provides soil protection benefits to agriculture in the range 1.6 € to 58.2 €. The results of the statistical analysis suggest that planting trees and the establishing of proper shares of wooded and cultivated areas will substantially contribute to the mitigation of erosion.

The cost-benefit analysis indicates that the costs for afforestation in the Ukraine will be covered by the returns at 0% through 4% discount rates, on average for the country. The analysis made across forestry zones shows that the highest gains from afforestation are to be received in the Steppe zone. This result can be largely explained by forest function to alleviate soil erosion in the Steppe, where it causes sandy storms and brings substantial economic losses. The benefits from afforestation are high also in the Wooded Steppe zone and the Carpathians. The results of the cost-benefit analysis provide evidence that when only timber supply gains and the benefits from the protection of agricultural lands against erosion are taken into account, planting trees is not economically justified in the Polissja and the Crimea for the discount rate of 2% and higher. Thus, considering timber supply and soil protection benefits, the programme is to be limited to the Steppe and Wooded Steppe zones, and the Carpathains, totally 1.82 million ha, when the discount rate of 2% is employed. As the results of LP modelling have shown, when the discount rate of 4% is used, it is economically efficient to plant trees only on bare lands in these zones, on the total area of 0.42 Mha. The newly established plantations will provide a long list of other benefits, however, they are not within the scope of this chapter.

Though planting trees in the Ukraine will enlarge social benefits to agriculture and forestry, and will add to the welfare of the society, welfare maximisation conditions will not be met, because of market failures. This justifies public policy concerning tree-planting. Due to the fact that the present value costs of afforestation will be covered mainly by the gains obtained in agriculture from the prevention of erosion (Table 5.12), and these social gains can not be achieved without State regulation, the role of the government remains very important. The State Committee of Forestry is to guide practical implementation of the proposed afforestation strategy, which is to be based on centralised investments. As the practice of the creation of forest plantations in the Ukraine has shown, annually 70 thousands ha of land can be planted with trees (Gensiruk and Nizhnik, 1995). About 25 years, therefore, are needed to implement the programme. In this study, however, temporal and spatial dimensions of the programme implementation are not considered.

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Appendix 5.1.

In the Ukraine, in view of the environment, optimum wooded area is such that allows to sustain natural ecological balance (Rejmers, 1990). The projections on the optimum wooded area per administrative regions of the country (Table 1) were made on basis of environmental criteria with the major focus on hydrological and soil protection forest functions that are deemed to be the priorities for the Ukraine (National Academy of Sciences, 1998). The estimates per forestry zone are shown in Table 5.2.

Table 1. Wooded area of the Ukraine in 1946-1996 per administrative area, %

Region	1946	1956	1966	1976	1986	1996	Optimum	Stock of stands, m^3 /ha
Vinnytsja	10.0	10.7	11.2	11.7	11.4	11.5	16	144
Volyn	17.2	23.1	28.0	30.7	29.2	30.4	37	134
Dnipropetrovsk	1.9	2.6	2.4	3.3	3.0	3.6	8	72
Donetsk	2.8	4.2	4.2	5.6	4.8	4.8	12	113
Zhytomyr	24.1	27.8	29.2	31.0	31.7	31.3	37	190
Zacarpathian	48.1	47.7	46.6	48.2	49.7	50.0	55	276
Zaporizhja	1.3	1.6	1.8	1.2	1.2	1.3	5	48
IvanoFrankivsk	35.8	34.3	33.8	32.9	39.6	40.7	49	216
Kiev	14.3	17.3	18.4	19.5	20.1	19.4	25	184
Kirovograd	4.6	4.5	4.8	4.0	4.1	4.5	11	136
Lugansk	5.2	6.2	6.4	8.2	8.6	8.8	16	101
Lviv	24.9	24.0	24.8	25.4	25.5	28.0	30	189
Mykolajiv	0.8	1.5	1.9	1.9	1.6	1.9	7	56
Odesa	2.4	3.4	3.7	3.5	3.8	4.1	9	104
Poltava	5.0	6.5	6.4	7.1	7.8	7.5	15	142
Rivne	28.5	30.9	32.4	35.5	36.1	36.2	40	116
Sumy	13.6	14.2	14.7	15.5	16.0	16.3	21	221
Ternopil	11.2	10.7	11.2	12.0	12.6	12.9	20	138
Kharkiv	8.9	9.2	10.3	10.3	10.4	10.7	15	148
Herson	1.6	1.8	2.0	3.5	3.1	3.1	8	85
Hmelnytsky	10.8	10.9	10.8	11.4	11.6	11.9	17	150
Cherkasy	-	11.5	12.4	13.2	13.7	13.8	16	164
Chernivtsy	25.8	27.6	26.2	28.0	28.8	28.8	33	234
Chernigiv	15.1	16.5	16.6	17.7	18.9	19.2	23	177
Crimea	-	9.2	9.8	10.0	9.8	10.1	19	130
On average	10.3	12.4	12.9	13.7	14.2	14.5	20	171

Source: National Academy of Sciences of the Ukraine (1998)

Appendix 5.2. Environmental Forest Functions

The role of forests in soil protection is related to their hydrological functions. Forests decrease surface water flows, slow down the process of snow melting, stabilising the stocks of groundwater, decreasing floods and supporting river regimes. Water regulatory impact of forests is particularly important in the Carpathians, where average annual amount of rainfall is up to 1600 mm. The Carpathians annually evaporate almost 20 km^3 of water, providing moisture to the unwooded areas of Europe (Nijnik, 1998).

In addition to soil and water protection functions of forests, their function to clean water is worth to be mentioned. General annual water consumption in the Ukraine is around 36 km^3, and water resources are limited. The deficit of clean water is caused not only by growing water consumption, but also by water pollution. Forests purify water from pesticides and chemicals on average by 60-90%, and decrease bacteriological contamination on average 20 times (Gensiruk et al., 1982). Thus to decrease the deficit of drinking water in the Ukraine, instead of creating big and expensive water reservoirs, which negatively impact the environment, the extension of wooded area could be considered as an alternative (National Academy of Sciences, 1992).

Forests are also important with regard to air pollution. There are areas in the Ukraine, where 5 tons/ha of dust come annually to the atmosphere. Forests purify the air and enrich it with active oxygen. One ha of spruce forest is able to accumulate 32 t of dust, one ha of pine forest 36 t, and one ha of beech forest accumulates 68 t of dust (Gensiruk, 1992). Purifyng the air, forests themselves are impacted by air pollution, e.g. within Lysychansko-Rubezhansko-Severodonetsky and Cherkasy agglomerations.

On the 26 of April 1986 a global environmental disaster occurred in the Ukraine. According to the official sources of information, the outflow of radioactive elements into the environment exceeded 50 million Curi. After the accident, forests played important role in slowing down the nuclear expansion (Ministry of Environmental Protection, 1998).

Table 1. Forest area affected by Chernobyl accident

Level of radioactive contamination of forests area	Forests area, mil.ha
Investigative forestry area:	10.0
Radioactive contamination of wooded area;	2.3
Including Curi /km^2	
0.1 - 1.0	0.7
1.0 - 5.0	1.4
5.0 – 15	0.1
15.0 and higher	0.03

Source: Ministry of Environmental Protection and Nuclear Safety (1993).

Being protectors of the environment, forests suffer from radioactive contamination. It affected forests not only within 30 km zone that has been excluded completely from any form of economic activity, but on the area of 2.3 million hectares. Three forestry enterprises with the forest's area of 46,000 ha where nuclear contamination by 137 Cs exceeded 15 Curi/km^2 were excluded from exploitation. About 157,000 ha of forests have high levels of contamination by Cs, Cs, Sr, Pt. The largest areas of polluted forests are located in Zhytomyr region (439,000 ha), Kyiv and Rivne (194,300 ha).

Appendix 5.3.

Given that theory suggests that neither the share of wooded cover, nor the rates of erosion can be less than 0%, so that a linear functional form is not logical, a number of other functional forms are been checked. The statistical analysis of the estimations shows that the best fit is achieved by using the following equations for the Ukraine and across its forestry zones. All parameter estimates are statistically significant (at p=0.05) and coefficients have expected signs and magnitudes.

Table 1.

Regression Analysis: Forest Cover-Erosion Rates in the Ukraine

Dependent Variable: LOG(ERO)
Method: Least Squares
Date: 10/22/01 Time: 13:02
Sample: 1 111
Included observations: 111
LOG(ERO)=C(1)+C(2)*WOOD

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	3.465274	0.118958	29.13025	0.0000
C(2)	-0.032863	0.003504	-9.379475	0.0000

R-squared	0.446629	Mean dependent var	2.564560
Adjusted R-squared	0.441552	S.D. dependent var	0.989821
S.E. of regression	0.739687	Akaike info criterion	2.252675
Sum squared resid	59.63794	Schwarz criterion	2.301495
Log likelihood	-123.0235	Durbin-Watson stat	1.532420

Table 2.

Regression Analysis: Forest Cover-Erosion Rates in the Carpathians

Dependent Variable: LOG(ERO)
Method: Least Squares
Date: 12/19/01 Time: 16:52
Sample: 18 35
Included observations: 18
LOG(ERO)=C(1)+C(2)*WOOD

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	4.370161	0.800377	5.460129	0.0001
C(2)	-0.052262	0.013102	-3.988921	0.0011

R-squared	0.498613	Mean dependent var	1.297735
Adjusted R-squared	0.467277	S.D. dependent var	1.264650
S.E. of regression	0.923041	Akaike info criterion	2.782154
Sum squared resid	13.63209	Schwarz criterion	2.881084
Log likelihood	-23.03938	Durbin-Watson stat	0.689310

Appendix 5.4.

The Problem of Establishment of Forest Plantations in the Ukraine

```
! [Visual XPRESS]
! [Visual XPRESS Integer]
! 1=1
! [End Visual XPRESS]
MODEL FOREST

!Defining indices

TABLES -i Z
TABLES -i A
TABLES -i T
TABLES -i M

DATA

Z = 4
A = 3
T = 4
M = 3

!Defining constants

TABLES

O(Z,A,T,M)  !Output
P(Z,A,T,M)  !Profit
B(Z,A,T,M)  !Soil protection benefit
C(Z,A,T,M)  !Cost
F(Z,A)      !afforestation in zone z of area A
test(Z,A,T,M)

DISKDATA O = Output.csv
DISKDATA P = price.csv
DISKDATA B = B.csv
DISKDATA C = Cost.csv

DATA

F(1,1) = 120000
F(1,2) =  60000
F(1,3) =  70000
F(2,1) = 280000
F(2,2) = 370000
F(2,3) =  60000
F(3,1) = 130000
F(3,2) = 140000
F(3,3) = 670000
F(4,1) =   1000
F(4,2) = 160000
F(4,3) =      0

VARIABLES

X(Z,A,T,M)
```

```
!Define objective and operational constraints

ASSIGN

!For (z=1:Z,a=1:A,t=1:T,m=1:M): O(z,a,t,m) * P(z,a,t,m) + B(z,a,t,m) -
C(z,a,t,m) = test(z,a,t,m)

CONSTRAINTS

Result: SUM(z=1:Z,a=1:A,t=1:T,m=1:M) X(z,a,t,m) * (O (z,a,t,m)*
P(z,a,t,m) + B(z,a,t,m)- C (z,a,t,m))$

MaxF(z=1:Z, a=1:A): SUM(t=1:T,m=1:M) X(z,a,t,m) <= F(z,a)
!each zone and area has a maximum afforestation limit

NA1 (a=1:A,m=1:M): X(1,a,3,m) = 0
NA2 (a=1:A,m=1:M): X(1,a,4,m) = 0
NA3 (a=1:A,m=1:M): X(2,a,3,m) = 0
NA4 (a=1:A,m=1:M): X(2,a,4,m) = 0
NA5 (a=1:A,m=1:M): X(3,a,2,m) = 0
NA6 (a=1:A,m=1:M): X(3,a,3,m) = 0
NA7 (a=1:A,m=1:M): X(3,a,4,m) = 0
NA8 (a=1:A,m=1:M): X(4,a,1,m) = 0
NA9 (a=1:A,m=1:M): X(4,a,2,m) = 0
NA10(m=1:M):       X(4,2,4,m) = 0
NA11(t=1:T,m=1:M): X(4,3,t,m) = 0

GENERATE
PRINT
test
X
O
B
C
P
F
```

6. AFFORESTATION STRATEGY TO MITIGATE CLIMATE CHANGE[71]

Contribution to climate stability is one of the criteria of sustainability in forestry. Forests remove carbon dioxide from the atmosphere and store it as carbon in terrestrial ecosystems, playing important role in climate stabilisation. Growing trees act as sinks, absorbing carbon from the air. Mature forests, whose carbon flows are in balance, play the role of reservoirs. Thus the forest sector offers climate mitigation opportunity, and apart from economic and environmental benefits, the expanded wooded area puts forward an attractive economic alternative to reducing carbon emissions. In addition to enlarging carbon sequestration benefits of growing and mature forest stands, the expansion of wooded area contributes to timber supply, and wood used in products serves as carbon sink for many years after timber harvesting.

6.1. Introduction

Various aspects of using forests to mitigate climate change have been broadly discussed in the literature for Canada, Finland, the Netherlands, Russia, the USA and some other countries (Adams et. al., 1999; Alexeyev and Birdsey, 1998; Bateman and Lovett, 2001; Peng and Apps, 1998; Pettenella, 2000; Sikkema and Nabuurs, 1995; Slangen et. al., 1997; Van Kooten et. al, 1993). The issue of terrestrial carbon sinks was a major item on the agenda of international conferences, as the COP-6 conferences in The Hague (2000) and Bonn (2001) and the COP-7 conference in Morocco (2001).

The Ukraine is a moderate air polluter. It has already reached its targets to stabilise emissions at 1990 levels by the commitment period of 2008-2012. This means that, before the increase in its sink claims, the country stands to profit from the sale of "hot air", the amount by which its emissions have been reduced further than their target levels (Corporate Europe Observer, 2001). The most recent regional scenarios for the emissions of CO_2 provide evidence that, during the Kyoto Protocol's 2008-2012 budget period, the surplus of the country will not fall lower than 3 Mt C per year. In 2015, in the baseline scenario with implementation of mitigation measures, emissions are expected to be 45 Mt CE[72] less than they were in 1990 (Ministry of Environment, 1998). Even scenarios with high economic growth and carbon intensive technologies do not exhaust Ukrainian "hot air" before 2012 (Victor et al, 2001).

In addition to selling its "hot air" to other countries that can afford to buy it and keep polluting, the Ukraine can sell its carbon uptake services from forestry. With the completion of talks in Morocco, key decisions on terrestrial biospheric sinks were taken. The carbon sink option has become eligible, and it includes forest management and soil carbon, in addition to afforestation and reforestation, but not wood product sink. Thus, pertaining to climate change mitigation the proposed afforestation programme appears promising, because by expanding wooded area the Ukraine can

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[71] Adapted from this Chapter a paper Mitigating Climate Change via Afforestation is published in the book: H. Essman and D. Pettenella (eds.) *Forestry in Transition. Redefining the role of forestry sector in Ukraine*. Padova University, 2002: 160-175.

The paper Contribution to Carbon Cycle and Climate Stability via Expansion of Azonal Boreal Forests in the Ukrainian Carpathians was presented at the Conference *The Role of Boreal Forests and Forestry in the Global Carbon Budget*, Canada, p.58. The paper is accepted for publication by the Canadian Forest Service, 2002: 1-10.

[72] Carbon equivalent.

create carbon credits that it can offer for sale to other Annex B countries. There exists a possibility of a trade between highly developed countries where carbon dioxide emissions are high and the Ukraine (UNFCCC, 1998).

The investigation of the economics of forest plantations on CO_2 emissions is required as a starting point for substantiating the option of selling carbon offset services by the Ukraine. In this respect it is important to analyse the potential to mitigate climate change by creating tree plantations, to assess stock and flows of carbon in forests, and to estimate the required investments. I investigate planting trees for carbon sequestration as a separate study. The programme of afforestation for carbon uptake necessitates planting different tree species and employing different management regimes than the establishment of forest plantations with the purposes of an increasing timber supply, and the protection of lands from erosion. While afforestation programme put forward in Chapter 5 is to be implemented in view of enlarging social welfare in the Ukraine, planting trees for carbon sequestration can be considered by the government only under conditions of selling carbon offsets and receiving credits for planting trees. This study is seen, therefore, as a base for initiating international carbon trade negotiations.

Chapter 6 explores the potential of afforestation of waste and highly eroded unwooded lands within the State Forest Fund and also marginal agricultural lands in the Ukraine as an option to initiate carbon trade negotiations. Using cost-benefit analysis as an evaluation criterion, I judge if planting trees in the country is an economically efficient way of removing carbon from the air. Section 2 presents an assessment of the expansion of carbon uptake by afforestation and the economics of carbon sink in trees: a storage option. I examine the case, when trees are planted for a period of 40 years, without considering future use of wood and land after timber harvesting. In Section 3, I discuss costs and benefits of carbon sequestration when other policy options are applied. This section considers economics of substitution wood for fossil fuel and of storing carbon in wood products. The conclusions consider why and how responding to the Kyoto Protocol with afforestation in the Ukraine is feasible.

6.2. Expanding Carbon Uptake by Afforestation

6.2.1. Background

The emissions of greenhouse gases, as carbon dioxide, result in climate change and global warming with consequences for the global environment and economic systems. In response to the threat of climate change, countries are taking commitments to reduce or to stabilise their CO_2 emissions. In 1998, Ukrainian emissions of CO_2 amounted to 360 Mt, comprising 1.6% of the world's total (IEA, 2000). In the baseline scenario, with implementation of climate change mitigation measures, the projected carbon emissions in the Ukraine are shown in Table 6.1.

Table 6.1. Carbon Dioxide Emissions/Removals, in Tg=Mt

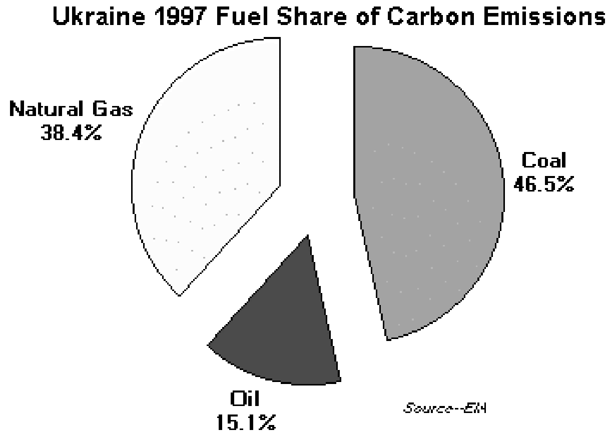
	1990	1995	2000	2005	2010	2015
			Direct Emissions of CO_2			
CE*	194.0	116.0	144.6	155.2	163.1	173.0
			CO_2 uptake in forestry			
CE	-14.2	-17.7	-18.2	-18.7	-19.3	-19.9
			Net			
CO_2	659.3	360.4	463.4	500.5	527.3	561.4

Source: Ministry of Environmental Protection (1998)

*CO_2 emissions in carbon equivalent: CO_2 multiplied by 12/44

The country's economy is highly dependent on coal, but since 1992, coal's share in the Ukraine's carbon emissions has dropped over 30% and coal consumption is down 39%. Consequently, the country's emissions of carbon dioxide are relatively low and its role as a carbon emitter on the world stage is insignificant (US EIA, 2001). Coal makes up nearly half of fuel shares of the Ukraine's CO_2 emissions, with the remainder coming from natural gas and oil (Figure 6.1.)

Figure 6.1.



Present relatively low levels of the Ukraine's CO_2 emissions are largely a consequence of the country's economic problems related to the transitional period. Because the Ukraine relies heavily on coal for its energy consumption, any possible rebound of the country's national economy will result in higher carbon emissions total (US EIA, 2001). Therefore, when the Ukraine's economy recovers, in order to stabilise its increasing domestic emissions, the country will have to introduce appropriate policy measures. Out-of-date technology, energy inefficiency and high carbon intensity make the introduction of cleaner production on a national scale hardly viable for the country in the near future. Thus, among carbon dioxide emission reduction measures, the enhancement of greenhouse gas "sinks" and "reservoirs" via afforestation and forest protection could be a priority.

Though today the Ukraine is a reasonable polluter, it is one of the most energy-intensive countries in the world, because of its energy inefficient industries.[73] Moreover, with country's reliance on coal and with energy inefficiency of the economy, the carbon intensity is also high.[74] As for per capita carbon emissions (Figure 6.2), the Ukraine's performance is somewhat better than that of the United States and Russia, while higher than its neighbours, Romania, Poland and Turkey (US EIA, 2001).

The Ukraine has taken several actions to promote lower energy consumption, higher energy efficiency and the reduction of its CO_2 emissions. In June 1992, as an Annex 1 country under the United Nations Framework on Climate Change, the Ukraine signed the Climate Change Convention, which was ratified by the Parliament. By 1998,

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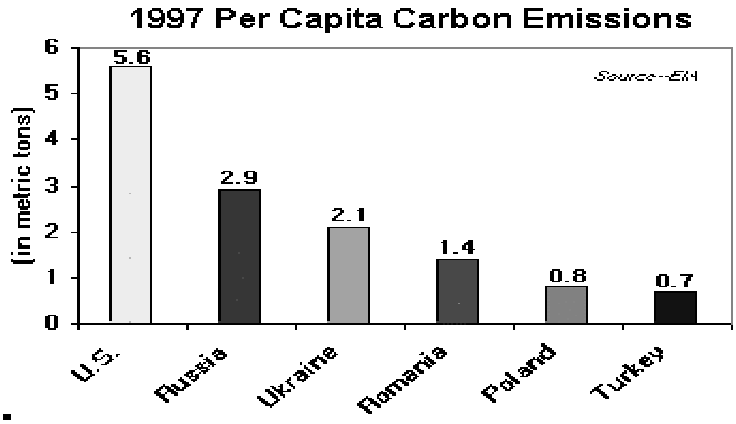
[73] TPES/GDP indicator (1998) for the Ukraine is 3.82, to compare it with 1.74 for Russia, 0.21 for the Netherlands or 0.35 for Canada. TPES, country's total primary energy supply, that is made up of indigenous production, plus imports, minus exports, minus international marine bunkers, plus-minus stock changes (IEA, 2000).

[74] CO_2 / GDP indicator (1998) for the Ukraine is 9.59, to compare it with 4.23 for Russia, 0.49 for the Netherlands or 0.72 for Canada (IEA, 2000).

over 170 countries joined the Convention. The Conference of Parties that took place in December 1997 adopted the Kyoto Protocol containing modified emissions commitments. In 1999, the Ukraine signed the Kyoto Protocol that is to be ratified by the Parliament. According to the agreement, by 2008-2012 the country has to stabilise its emissions of greenhouse gases (GHG) at their levels of 1990.

Figure 6.2.



The Annex B countries of the Kyoto Protocol, including the Ukraine, committed to reduce their collective emissions of six key greenhouse gases by at least 5%. During the last decade, the Ukraine's emissions have been fallen by almost 50%. However, many industrialised countries have not succeeded in meeting their earlier non-binding aims of returning emissions to their 1990 levels by the year 2000. Actually, their emissions of GHG have risen since 1990, and therefore, the Protocol target of 5% collective emissions reduction in fact represents a 30% cut (Climate Change Information Sheet 21, 1997).

The Kyoto Protocol established three innovative mechanisms, known as joint implementation, emissions trading and the clean development mechanism, which were designed to help Annex B countries in meeting their emissions targets the cheapest possible way. The basis of these three mechanisms is trading. The trade presumes transfers of credits, allowances, permits and quotas, all of which are to be linked directly to the reduction of emissions of the greenhouse gases stipulated in the Protocol. Therefore, to assess the Ukraine's potential for climate change mitigation in forestry is a motivating study area. Carbon uptake in Ukraine's forestry is important for stabilising collective emissions via selling carbon offset services by the country, rather than for fulfilling country's own Kyoto commitments. Considering aforesaid, I intend to find out how Ukrainian forests and their expansion could help to moderate carbon emissions and what their contribution to climate mitigation strategies could be. Thus, the basic research question of Chapter 6 is to discover if Ukrainian forests offer a low-cost opportunity for carbon sequestration.

6.2.2. Forest biomass and carbon in the Ukraine

As a starting phase for the investigation of the quantity of carbon that could be sequestered by planting trees on wastelands and marginal agricultural lands, I provide estimates of carbon content in already existing Ukrainian forests. I also assess the net change in the carbon pool of the Ukraine's forest vegetation, during the period 1990-

2000. This estimate indicates the contribution of the existing forests to carbon uptake allotted throughout the last decade. The amount of carbon stored in already existing forests illustrates forests' contribution to the process of climate stabilisation and serves as a benchmark for assessing potential gains in carbon sequestration to be received through the expansion of the wooded area.

A generally accepted estimate of storage of carbon is forest biomass. Lakida et al. (1995) have estimated the biomass (dry matter) and carbon content of forests in the Ukraine. They assessed the biomass for coniferous, hard and soft deciduous species providing total estimates for the country. The data used in their analyses was collected from experimental research plots (Table 6.2).

Table 6.2. Forest Biomass and Carbon Content in Ukrainian Forests, Mt[75]

Phytomass Components	Coniferous	Hard wood	Soft wood deciduous	Total
Foliage	31.65	7.81	2.66	42.10
Crown wood	45.25	53.44	9.65	108.30
Stemwood	289.35	290.05	58.42	637.80
Stump and roots	55.03	45.78	18.38	119.20
Understory	14.63	24.80	9.78	49.2
Total	435.93	421.88	98.90	956.70
Phytomass density kg/m^2	11.07	12.09	8.27	11.10
Total Tg Carbon	215.65	209.31	48.83	473.80
Density kg/m^2	5.48	6.00	4.08	5.50

Source: Lakida et al. (1995)

Table 6.2 illustrates that possessing total forest biomass of 956 Mt of dry matter with carbon content of about 474 Mt, Ukrainian forests play important role in global carbon balance. The estimates for the Ukraine are lower than carbon pools of countries such as Canada (9.3 Gt C) and the USA (11-12.6 Gt C), but much higher than carbon in biomass of forests in the Netherlands (20 Mt C). Concerning carbon content per ha of wooded area, the estimates are comparable between the countries. In the Ukraine it is 55.1 Mg C per ha, in Canada 38.3 Mg C, in the USA 56.2 Mg C and in the Netherlands 59.7 Mg C per ha of forests (Nabuurs et.al, 1999).

On the basis of the estimates of carbon content in forest biomass, I have assessed the net change in carbon pool of the Ukraine over the last decade. In 1990, total forested area in the country was 8620.9 x 1000 ha with the growing stock of 1319.9 x 10^6 m^3 (State Committee of Forestry, 1998). During the last decade, the growing stock of forests in the Ukraine has increased by 417 x 10^6 m^3. The ratio between total biomass in dry matter and growing stock (expressed in tons of carbon per m^3) for average conditions is 0.359 tons of C/m^3, with 0.32 for coniferous, 0.39 for hardwoods and 0.34 for softwood deciduous (computed from the data in Table 6.2). Hence, over the last 10 years, the net change in the carbon pool of the Ukraine's forest vegetation was 149.4 Mt carbon. This figure corresponds to an average annual net uptake by forests of about 15 Mt of carbon, or around 1.6 t C $ha^{-1}yr^{-1}$, excluding carbon sink in forest's soil and litter.

[75] Tg (teragrams) corresponds to Mt, while tera corresponds to 10^{12}.

The estimates are close to those provided in Table 6.1. According to Nabuurs et al. (1999), average annual net uptake by forests in Canada is 0.64 t C $ha^{-1}yr^{-1}$, for the USA, this estimate is 1.6 C $ha^{-1}yr^{-1}$and it is 2.0 t C $ha^{-1}yr^{-1}$, for the Netherlands.

The above figures indicate that Ukrainian forests' potential of carbon uptake per ha is substantial, as that of forests in the USA, and higher than annual net uptake per ha of the Canadian forests, because of the vast forests of the north. The Ukraine has good forest growing conditions and productive forests all over its territory, except for the Steppe. In 1996, having sequestered 75.9 Mt of CO_2 from the atmosphere, forests have deposited 20.7 Mt of carbon. Logging has reduced the stock of carbon deposited in forests by 3.2 Mt and forest fires by 0.04 Mt (Ministry of Environmental Protection, 1998). Nevertheless, in 1996, actual net carbon uptake by Ukrainian forests exceeded 17 Mt C. This figure is very high and is close to our average annual estimate.

The following sections of this chapter discuss the potential to increase further carbon uptake by Ukrainian forests via the expansion of the country's wooded area. The proposed programme of the creation of forest plantations is examined as a means for the country to enlarge its contribution to climate stabilisation. The afforestation strategy that is aimed to increase carbon storage in terrestrial ecosystems could enable the Ukraine to play an important role in climate change negotiations under the emissions credit-trading scheme.

6.2.3. Carbon uptake potential

This study was carried out per forestry zone (Gensiruk and Nizhnik, 1995) and for the country, therefore, it is reasonable to define the benefits of tree-planting for the purpose of carbon uptake also on this basis. Forests store carbon by photosynthesis and carbon sequestration positively correlates with the growth rates of the trees. The most fast-growing species in the Ukraine is hybrid poplar. However, ecological and economic conditions of the country do not allow planting hybrid poplar all over the territory. Considering tree-growing conditions per forestry zones and the records of the Forest State accounts on tree growth, the following relatively fast growing species were recommended for planting for the purpose of carbon sequestration. Hybrid poplar was selected for planting in the Wooded Steppe; mixed species scenario (30% hybrid poplar, 20% alder and other hardwoods and 20% pine and other softwoods) in the Polissja; pine in the Steppe and in the Crimea; and spruce in the Carpathians. Benefits of carbon uptake were estimated in physical terms of carbon sequestration that depends on tree growth of the chosen species.

The assorted species studied per different forestry zones possess particular functional forms of tree growth. The functional forms for stand growth of the species proposed for planting with the purpose of carbon uptake are estimated using the data from the Ministry of Forestry (1988), which is based on the continuous records of the Forest State accounts. The statistical analysis of the estimations shows that the best fit is achieved by using exponential functional form $y = a_0 t^{a1} e^{a2t}$, in all forestry zones of the Ukraine and for all the examined tree species. The equations for the estimates of the stand growth related to the age of trees of the first site classes (the most productive and fast growing in particular conditions), are as follows. All parameter estimates are statistically significant (at $p=0.05$) and coefficients have expected signs and magnitudes.

For spruce recommended for planting in the Carpathians, the following functional form has to be employed (m^3):

$$V(t) = 0.159\, t^{2.240}\, e^{-0.018t}$$

Growth function of pine in the Crimea is (m^3):

$$V(t) = 0.704\, t^{1.648} e^{-0.010t}$$

For pine in the Steppe, the following growth function is to be used:

$$V(t) = 0.006\, t^{2.847} e^{-0.026t},$$

Growth function of hybrid poplar is as follows:

$$V(t) = 2.939\, t^{1.933} e^{-0.055t},$$

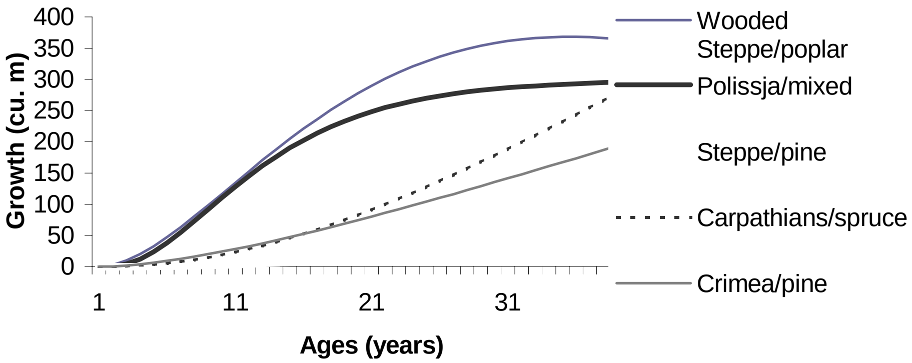
Because the data on growth rates of mixed species with (30%) hybrid poplar was not available, I assumed that it is described analogous to the growth of the mixed stands under similar conditions of Western Canada (Van Kooten and Bulte, 2000, p. 421-422) (m^3), as:

$$V(t) = 300\, (1 - e^{-0.14\, t})^3$$

where 300 m^3/ha is the maximum volume of stem wood for mixed species in the Polissja (State Committee of Forestry, 1998).

The growth for the most fast-growing tree species by zones of the Ukraine is presented in Figure 6.3. The figure illustrates that the growth of hybrid poplar proceeds quickly. Because carbon sequestration positively correlates with the growth rates of the trees, it likely reasonable to plant it for this purpose. The growth functions of the species considered for planting in the Carpathians and the Crimea substantially differ from those in other forestry zones. Though the trees here grow comparatively slow, when they reach maturity, they accumulate the volume of stem of 500 m^3 and higher. Therefore, their carbon storage function could be essential here. The growth functions in Figures 6.3 describe the growth of stem volume, but carbon that is taken from the atmosphere is stored not only in stem, also in branches, in leaves and roots of the trees and also in understory, in forest soils and litter.

Figure 6.3. Growth Functions of Tree Species per Forestry Zones of the Ukraine



Forest adds to the reduction of carbon dioxide from the atmosphere as long as there is a net growth. Then, forest acts as a carbon sink. In this study a 40-year time horizon is considered. The reason is that growth rates of stands of major tree species chosen for planting are increasing until the trees reach 40 years of age. Maximum sustainable yield rotation ages for the chosen species do not exceed 40 years. Consequently, the highest rates of carbon uptake are observed within this time horizon.

When trees are cut, the above ground biomass minus the commercial part of the bole that constitutes a log enters the litter account. Later on, when a new generation of trees comes up, there is a re-growth of the non-bole biomass and a re-growth of the volume of stem wood. The process is assumed to continue indefinitely with new generation of trees coming instead of old one. This observation allows us to consider at once all the above ground biomass of the trees. I use the coefficient of 1.51 for coniferous and 1.69 for softwood deciduous stands, as poplar and mixed species, to translate the bole biomass into total above ground biomass (Lakida et. al, 1995). In order to define the benefits of carbon uptake in physical terms, the stem volume is to be translated into carbon by multiplying by specific gravity that is the proportion of oven-dry weight in green volume and then by multiplying by 0.5 kg of C/kg of wood. To simplify the calculations, I multiply the volume of stem wood by 0.2 tC/m^3, the coefficient that is common in the literature (Jessome, 1977).

In addition to the above ground biomass I examine root components of forest that play a role in carbon budget. Carbon sequestered by the root pool is estimated in m^3 per ha, according to the following relationship (Van Kooten and Bulte, 2000):

$$R(G) = 1.4319\, G^{0.639}$$

where:

R – root biomass, m^3;

G – above ground biomass, m^3.

For spruce, it is the constant 0.2317 that relates root biomass to above ground biomass. The understory biomass of pine is related to its growing stock (Lakida, Nilsson and Shvidenko, 1995), as:

$$R(V) = 0.146\, (V)^{-0.519}$$

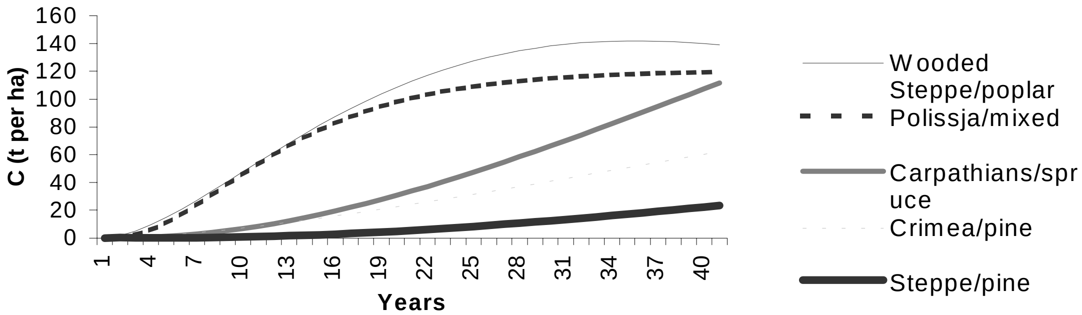
In line with the assessment of carbon content of already existing forests (Table 6.2), I do not account for soil and litter. When land is converted into forest, certain changes occur in soil carbon, but according to the Kyoto Protocol (UNFCCC, 1998) only commercial component of the tree is to be considered as a first approximation. Data on soil carbon is hardly available. In view of the variety of conditions in the Ukraine, there could be a decrease and an increase of carbon per ha after the conversion of the land into a wooded area. It is also difficult to determine soil carbon associated with different uses of the land. Considering above, changes that occur in soil carbon after planting trees were not taken into account. Since litter pool that consists of dead and dying biomass is a comparatively small account for the conditions of the Ukraine (AACM IPL, 1998), it is also not reflected in the current research.

There is a great deal of uncertainty in the area of climate change mitigation strategies, including those of sequestering carbon in forests. Firstly, it is so, because marginal damages from atmospheric carbon are not certain over time. There is also uncertainty on taking into account correctly the benefits to future generations of carbon control strategies. Hanley and Spash (1998) argue that even if the vote of upcoming generations over climate change mitigation strategies is to be accounted for, it will be impossible to do it right, because future preferences are unknown. Also, difficulties in estimating future benefits of carbon sink come up due to uncertainties about the dynamics of carbon in forest ecosystems. Here, considering the question of planting trees for carbon uptake, in addition to uncertainties associated with future economic, technological, environmental, biological and social aspects of mitigating climate change, there is a great deal of institutional uncertainty associated with property rights and managerial aspects of forestry-in-transition. Frequent changes in government policies, markets and social norms contribute to uncertainties. Cost-benefit analysis of planting trees to mitigate climate change, therefore, runs into uncertainties, and the extent to which mitigation strategies can be justified on efficiency grounds largely depends on the rate of discounting employed in the analysis.

Thus, an important question that arises while using cost-benefit analysis of planting trees to mitigate climate change is that of carbon discounting. The efficient degree of control of carbon concentrations would deemed to be zero in the case of high costs, low damages and high discounting and the other way round (Nordhaus, 1991). Often, the costs of mitigation strategies are high and if the value of the benefits from net emissions reduction were known, it would be easier to discount the expected benefits flow, the same way, as we discount the costs. However, the benefits of carbon uptake are not certain, and because of time preference at high discount rates (5-10%), the present value of any amount of carbon sequestered in some 50 years from now sharply approaches zero. Moreover, if to believe that a future technology will be able to reduce carbon emissions at almost no cost, high discount rate could be suggested. The opposite assumption results in inverse conclusions. The more rapidly CO_2 concentrations are projected to be increasing in time, the less future C should be discounted.

The study employs three settings. The first one presumes not to discount carbon and it suggests that the value of marginal carbon damages in the future will increase at the real rate of discount. This assumption implies that if all amount of carbon sequestered is valued equally, no matter when it is captured, and if the afforestation costs are equal for different stands (for instance, for poplar that is fast-growing, with initially high rates of carbon uptake but which growth soon decelerates, and for spruce that grows slower but much longer and in 100 years accumulates up to 300 tons of C per ha), then planting spruce could be preferred (Figures 6.4 and 6.5).

Figure 6.4. Cumulative Carbon Uptake by Most Fast-Growing Tree Species by Zone, 0% discount rate



However, from economic reasoning in long-term projections in forestry, setting a 0% discount rate is a very specific assumption. The cumulative carbon uptake is to be available 40 years from now, and in economics, it is important to judge costs and benefits according to their present value. Therefore, to justify economically the efficiency of carbon mitigation policies, positive discount settings of 2% and 4% are employed, as well. Discounting of carbon uptake benefits at a social rate of discount

(4%) presumes marginal damages from the emissions to be constant over time, and this is the most reasonable assumption since we have no evidence to predict any other scenario. Moreover, a 4% discount rate is applied for discounting of the costs. Thus, it is logical to use it also for discounting of the benefits of carbon uptake.

Table 6.3 illustrates that mean annual carbon uptake per ha of the proposed plantations in all forestry zones, except in the Steppe, is higher than present annual net uptake per ha of the existing Ukrainian forests (that is 1.6 t C $ha^{-1}yr^{-1}$, see section 6.2.2). This is because the most fast growing species under particular conditions were chosen for planting. The cumulative discounted C uptake varies considerably by forestry zone. This is due to the variety of conditions, which require growing different species in different areas. The highest estimate of C uptake in 40 years is for hybrid poplar in the Wooded Steppe.

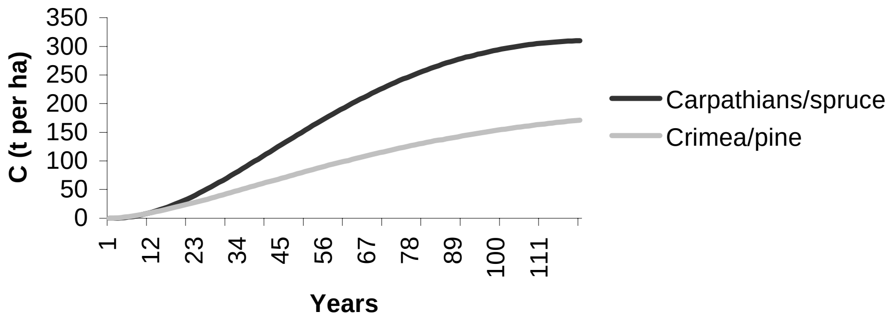
Table 6.3 Simulated Cumulative Carbon Uptake Over 40 Years and Mean Annual C Uptake per ha, Storage Scenario

Carbon (t C ha^{-1})	Polissja	Wooded Steppe	Steppe	Carpathians	Crimea
0%	119.5	139.0	23.3	111.6	62.2
2%	53.7	62.5	10.5	50.2	28.0
4%	24.1	28.1	4.7	22.5	12.6
Mean annual (t C yr^{-1})	3.0	3.5	0.6	2.8	1.6

Table 6.3 also indicates that the estimates largely depend on the discount rates, and that the figures received for the Ukraine, are comparable with the estimates provided for Canada (Van Kooten and Bulte, 2000), the Netherlands (Slangen et. al., 1997), or Finland (Pussinen et. al, 1997, etc.). On average for the Ukraine, 80 t C per ha is sequestered over the period of 40 years, or 18.0 t C per ha if C is discounted at 4%.

In addition, in view of particular growth functions of spruce and pine stands in the Carpathians and the Crimea, carbon uptake over a 120 years period was explored for these species (Figure 6.5).

Figure 6.5. Cumulative Carbon Uptake by Spruce and Pine in the Mountains over a 120-Year Time Horizon (a Storage Option)



Spruce and pine in the mountains accumulate high quantities of C when they reach maturity. Cumulative C uptake over 120 years by pine in the Crimea is about 200 t C per ha, and it is almost 300 t C per ha in spruce stands of the Carpathians.

The results show that the afforestation programme will increase total cumulative carbon uptake in Ukrainian forests by 180 Mt of C (C discounted at 0% rate) over a 40-year time horizon. Maximum amount of carbon that could be sequestered annually through afforestation is about 4.6 Mt or about 1.0 Mt if C is discounted at 4%. The comparison of these figures with the annual carbon uptake by the existing Ukrainian forests (15 Mt, see section 6.2.2) indicates substantial carbon uptake benefits to be received from the proposed strategy. For each ton of carbon sequestered in forest biomass 44/12 t of CO_2 is removed from the atmosphere. Therefore, 16.8 Mt of carbon dioxide (3.8 Mt if C is discounted at 4%) will be taken from the air annually. This amount of CO_2 roughly corresponds to 4.5% of the country's annual emissions.

In addition, total ton-years of carbon by forestry zone are computed over the period of 40 years and discounted at 4%, as:

$$C_{\text{ton-years}} = \left[\sum_{t=1}^{40} \frac{(C_t - C_{(t-1)}) \times (40 - t + 1)}{(1+r)^t} \right]$$

where

C_t annual carbon uptake in the year t, tons per ha;

C_{t-1} annual carbon uptake one year earlier, tons per ha;

r the discount rate.

Then, permanent amount of sequestered carbon is computed by each forestry zone and for the country. It was done by dividing total ton-years of carbon by 50 years that corresponds to the lowest conversion factor identified by the IPCC (2000) for converting temporary storage in a sink into a permanent ton of emissions reduction:

$$C_{\text{permanent tons}} = C_{\text{ton-years}} / 50$$

The estimates are calculated only for the above ground biomass. Allowing for 15€[76] price per ton of carbon uptake (Sandor and Skees, 1999), the benefits are computed and shown in Table 6.4.

Table 6.4. Carbon Uptake for the Above Ground Biomass in Permanent Tons and its Value per ha of the Zones for the Storage Option, at 4% discount

	Polissja	Wooded Steppe	Steppe	Carpathians	Crimea
Total ton-years of C	1846.2	2372.5	143.0	676.7	584.3
Permanent tons	36.9	47.5	2.9	13.5	11.7
Value of C uptake	553.9	711.8	40.1	203.0	175.3

According to our calculations, the benefits of carbon uptake by planting trees in the Polissja will be 144 M€ (9.6 Mt), in the Wooded Steppe 505.4 M€ (33.7 Mt), the Steppe 40.7 M€ (2.7 Mt), the Carpathians 34.7 M€ (2.3 Mt) and the Crimea 39.3 M€ (2.6 Mt). The storage option will bring benefits for the Ukraine up to 764 M€. This result is obtained while measuring carbon uptake in permanent tons.

6.2.4. Economics of carbon uptake in trees: a storage option

This section examines costs of carbon sequestration and presents initial cost-benefit analysis of the storage option. In the previous chapter I assess the social costs of planting trees per ha of the newly wooded area and by forestry zone[77], which appear to

[76] 1 USD roughly corresponds to 1 €.

[77] For simplicity, I assume that afforestation costs depend on forestry zone and current land use, rather than tree species.

be comparatively low (Table 5.4 and Table 5.7). Knowing these present value costs of afforestation and the amount of carbon sequestered, the present value costs per ton of carbon uptake are computed at different discount rates. The costs of one ton of carbon uptake in the Ukraine also appear to be comparatively low (Table 6.5).

Table 6.5. Present Value of C Uptake Costs, € per ton C*

Forestry zones	€ per ton at the discount rates of		
	0%	2%	4%
Polissja	5.8	7.1	8.7
Wooded Steppe	4.6	5.9	7.2
Steppe	78.5	120.0	173.3
Carpathians	8.7	12.7	17.9
Crimea	16.2	15.6	32.0
The Ukraine	9.5		18.1

*C is in permanent tons

Average for the country costs of sequestering carbon that include tree-planting, care and protection, and opportunity costs of land are 9.5 € per ton of carbon if carbon is not discounted and 18 € per ton when costs and benefits are discounted at the same discount rate of 4%.

The costs of carbon sequestering vary substantially by forestry zone. The diverse conditions for tree-plating and tree-growing in various zones predetermine the discrepancy in the establishment and management costs, the so-called direct afforestation costs. The distinct net returns from marginal agricultural lands that are to be planted with trees differentiate the opportunity costs of tying up potential agricultural lands for long periods. The highest carbon sequestration costs are in the Steppe zone, especially for marginal agricultural lands that are used for wheat production and where the opportunity costs of land are relatively high. The lowest carbon sequestration costs are in the Wooded Steppe zone, those of planting the most fast-growing species, hybrid poplar. Usually, hybrid poplar is planted on bare lands, including the lands that are managed by the State Committee of Forestry where the opportunity costs of land are deemed to be zero.

The usefulness of this chapter derives from the elaboration of present value (PV) costs per ton of carbon uptake for each policy scenario rather than from analysing the costs and benefits of carbon uptake. The reason is that the costs per ton of sequestered carbon enable a comparison of carbon uptake policy of the creation of forest plantations (three scenarios under investigation) with various other climate mitigation policy alternatives, e.g. emission reduction, etc. Though the scope of this chapter does not proceed to analysing these various alternatives, it provides important benchmark for such type of analysis to be done in the future. The main reason for calling the cost-benefit analysis elaborated in this chapter across the policy scenarios "initial" is that price per ton of carbon uptake is assumed to be stable in this study. However, the development of a market with an increase in the amount of carbon credits available to buy is pushing the price of credits down. Consequently, it will be cheaper for the richer countries to buy their way out of their responsibilities to reduce emissions. It has become obvious after the conference in Morocco (2001) [78]. If in the early 1990s, the price of 1 ton of carbon uptake was 28 USD (Wiens, 1992), today it is 15 USD (Sandor and Skees, 1999). The current cost-benefit analysis (Table 6.6) employs an assumption that the price of C uptake is 15 € per ton.

Table 6.6 Initial Cost-Benefit Analysis, C Storage Scenario

Forestry zone	PV estimates at 4% discount rate			
	Value of C*, €/ha	Costs, €/ha	NPV benefits, €/ha	NPV benefits, M€/zone
Polissja	553.9	320.5	+233.4	+60.7
Wooded Steppe	711.8	343.9	+367.9	+261.4
Steppe	42.9	502.5	-459.6	-430.0
Carpathians	203.0	241.0	-38.0	-6.5
Crimea	175.3	374.6	-199.3	-44.7

*C is in permanent tons

The estimates presented in Table 6.6 suggest that the net present value of the programme is positive in the Polissja and Wooded Steppe where fast-growing hybrid poplar is suggested for planting. In these zones forest plantations appear to be cost-effective means of carbon uptake. The estimates are also pretty good and appear to be positive, when carbon uptake benefits are discounted at 2%, for spruce stands in the Carpathians. In the Steppe zone and the Crimea, planting trees for carbon sink is not recommended. The next step of the research considers benefits from afforestation, when trees are cut as their growth slows down.

6.3. Costs and Benefits of Carbon Sequestration: Other Policy Options

Usually trees are used after a certain time horizon. While carbon uptake in a storage option has just one time effect, and eventually, through the decay of wood carbon is released back to the atmosphere, fuel and product substitution strategies are repeatable, and thus, in a long-run, they are more effective and sustainable means of carbon management. The additional timber to be received from the newly forested lands enlarge the supply of wood for the forest industry, but also carbon stored in wood products is an addition to the total carbon sink. Another policy option suggests to use extra wood received from the plantations as a substitute for fossil fuels. This alternative policy solution also contributes to carbon sinks provided by forests and to the reduction of carbon dioxide concentrations in the atmosphere. In this section, I examine cost-effectiveness of these two strategies, by taking into account timber harvesting and using of wood as a fuel and also as a raw material.

6.3.1. Carbon uptake under substitution wood for fossil fuel scenario

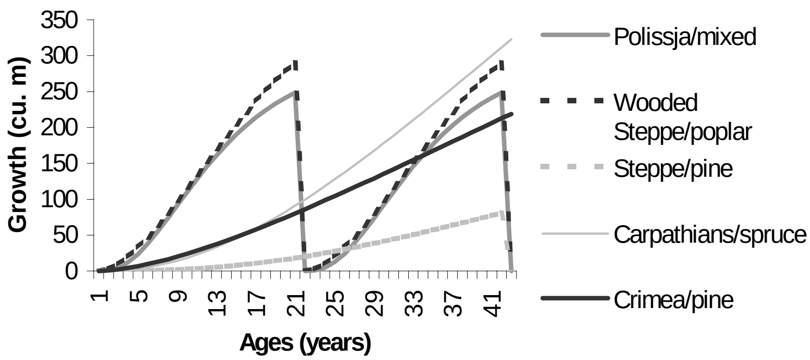
Considering scarcity of natural oil, high costs of coal extraction and all range of problems connected with nuclear power plants, especially after the Cernobyl accident, the option of wood biomass burning to generate electricity is investigated as a possible alternative of a storage climate mitigation strategy. Trees are removing carbon from the

[78] During COP-7, Russia managed to nearly double its carbon credits associated with business-as-usual forest management.

atmosphere during the time of their growth. When trees reach culmination of their annual increment, they stop sequestering carbon, because removal due to the growth of trees comes into a balance with loss due to the decay of the trees, and forest acts as a carbon sink. Carbon storage would be optimised in plantations when timber is harvested at the age of trees that correspond to maximum annual increment. This section discusses the possibility of timber harvesting when trees reach mean annual increment and the option of burning wood instead of fossil fuel. A 40-year time horizon is considered.

The analysis of the growth functions of the species planted per zone (Figure 6.4) allows us to conclude that for hybrid poplar in the Wooded Steppe zone, C uptake roughly proceeds until the trees reach the age of 20 years. The same concerns a mixed species scenario with 30% of hybrid poplar in the Polissja. Thus, in the Polissja and Wooded Steppe two rotations will take place in 40 years. In the Steppe zone pine will be harvested only once, because carbon uptake proceeds much slower, until the growth of trees decelerates when they reach the age of 40 years. Thus, the substitution wood for fossil fuel policy considers the case when trees are planted and then harvested at the age of 20 or 40 years (Figure 6.6). Since forests in the Ukraine are managed by the State Committee of Forestry, and the programme is to be carried out and financed by the government, a one-time planting and harvesting of trees for each timber rotation is assumed as a first approximation.

Figure 6.6. 40 Years Growth of Trees Under the Scenarious that Trees are Harvested



After harvesting the wood is burned to generate energy and to replace an energy equivalent amount of fossil fuel. Only the above ground carbon fixed in wood is suitable for generating energy. When wood is used for energy production, C stored in wood biomass is released as CO_2 upon burning. Thus using timber for energy is by itself a carbon neutral process. The net gain here is the amount of carbon dioxide that would have been released by burning fossil fuel, if not replacing it with wood biomass (Slangen et. al, 1997).

In the Ukraine, electricity is generated mainly through burning of coal. Carbon content of coal is comparatively low, about 0.6 kg of carbon per 1 kg of coal (US EIA, 2001). To receive 1 GJ of energy, 24.12 kg of carbon in coal are to be burned. Thus, 1 kg of carbon generates some 0.04 GJ of energy, and 0.6 kg of carbon, or 1 kg of coal, will produce 0.024 GJ of energy. Thus, 24 GJ of energy is produced per ton of coal in the Ukraine. If trees are planted to generate electricity, then on an energy-equivalent basis, for every ton of coal 4.5 m^3 of wood is needed to receive the same amount of energy (24 GJ), and to offset the release of 0.6 t of C to the air.

The simulation results (Figure 6.6) indicate that, in 40 years, 77 m^3 per ha will be available in the Steppe area. The wood available per hectare substituted for coal in generating electricity could prevent the release of 10 t C in the Steppe zone. The policy of burning wood to be harvested in the Steppe zone would prevent the release of 9.6 Mt of C. In the Polissja and the Wooded Steppe, harvesting of hybrid poplar and mixed species is to take place when trees reach 20 years of age. Thus during a 40-year time horizon, two rotations will occur. At harvest time, about 250 m^3 of wood per ha will be available in the Polissja, and 300 m^3 of wood per ha will be available in the Wooded Steppe zone (Figure 6.6). The wood available per hectare, being burned instead of coal, will prevent the release of 33 t of carbon in the Polissja and about 40 t of carbon in the Wooded Steppe zone.

On basis of the considerations presented above, though with carbon discounting at r% total carbon saving estimates for the alternative energy scenario are computed, as follows:

$$C_{saving} = C_{uptake\ perm.\ tons} + C_{burning}$$

$C_{uptake\ permanent\ tons}$ is computed for the above ground biomass as it was done earlier for the storage scenario;

$$C_{burning} = (C_{above\ ground} \cdot 0.6) / 4.5\ (1+r)^{\tau}$$

where,

$C_{above\ ground}$ cumulative carbon uptake over the period of timber rotation;

0.6 and 4.5 are the coefficients. Their incorporation in the equation means that for every ton of coal 4.5 m^3 of wood is needed to receive the same amount of energy and to offset the release of 0.6 t of C to the air.

τ is a period of timber rotation.

Carbon uptake estimates for the wood for fossil fuel substitution scenario when the discount rate of 4% is employed are shown in Table 6.7.

Table 6.7. Carbon Estimates per ha, Alternative Energy Scenario

	Polissja	Wooded Steppe	Steppe
Discounted C savings from burning	25.6	32.9	3.2
Total C savings	64.0	80.3	6.1
Value of C savings, €	959.7	1204.8	91.5
Net benefits	-89.1	116.2	-642.5

As seen in Table 6.7, the highest carbon savings are in the Wooded Steppe zone for hybrid poplar. The value of carbon uptake in the Wooded Steppe zone over a 40-year time horizon is expected to be 856 M€ (57.0 Mt), in the Polissja it is about 250 M€ (16.6 Mt) and in the Steppe 85.6 M€ (5.7 Mt). These estimates are higher than when the storage policy option was considered.

While computing net benefits of carbon uptake, the costs that are taken into account include initial planting costs, care and protection costs, opportunity costs of land, replanting costs and the costs of timber harvesting. The costs of converting power plants to wood are ignored in this research. The net benefits of carbon saving appear to be positive only in the Wooded Steppe zone where hybrid poplar is recommended for planting. Alternative energy scenario is not considered for the Carpathian and the Crimean zones, because commercial harvesting is restricted in the natural reserves.

6.3.2. Economics of substitution wood for fossil fuel

The costs of wood-for-coal substitution policy per ton of carbon saving, discounted 4% are as follows: in the Polissja 36.4 €, the Wooded Steppe 32.3 € and in the Steppe 124.6 € per ton of C, when carbon is computed in permanent tons. The costs do not account for production costs of coal. If to analyse the estimates and to compare them with the similar estimates derived, for instance for the Netherlands (Van Kooten and Bulte, 2000), we may conclude that the costs per ton of carbon under the energy scenario are low in the Ukraine. On average for the country the costs per ton of carbon savings under fuel substitution scenario are about 70 € at the discount rate of 4%.

In addition to carbon saving benefits that in the Steppe are 91.5 € per ha (Table 6.7), the calculations as follows have been made. Considering the returns from planting pine in the Steppe and harvesting it in 40 years, the results of the simulations show the following. Given that at harvest time in the Steppe pine has about 77 m^3 per ha (Figure 6.6), and the stumpage value of timber in the Ukraine is 4-5 €/m^3 (Nilsson and Shvidenko, 1999), the returns from planting pine and harvesting it in 40 years will be about 346.5 € per ha, with their present value over 72.2 € per ha (at 4% discount rate). Also, because for each ton of coal 4.5 m^3 of wood is needed in order to receive the same amount of energy, wood available per hectare in the Steppe at harvest time is a substitute for 16 tons of coal in generating electricity. The production costs of 1 ton of coal in the Ukraine exceed 50 € (US EIA, 2001). Therefore, wood available per ha in the Steppe being used instead of coal saves 802 €, with their present value of 167 €. Considering aforesaid, total discounted returns from the implementation of fuel-for-wood substitution policy option for the Steppe are close to 332 € per ha. However, if to compare the discounted returns from planting pine in the Steppe with the discounted costs of the policy, which are 638 € per ha, the discounted net returns appear to be negative. The discounted net returns of planting trees for carbon uptake are substantially negative for the lands in the Steppe zone suitable for wheat production.

As harvesting is forbidden in the protected areas of the Carpathians and the Crimea, I do not estimate net returns from timber harvesting in these zones. The discounted returns from planting mixed tree species in the Polissja will exceed 743.3 € per ha and 193.5 M€ per zone. The comparison of these figures with the discounted costs of implementation of wood-for-coal substitution policy option shows that the discounted net returns are negative. They keep being negative also if to account for carbon saving benefits discussed above. In the Wooded Steppe zone, those of planting hybrid poplar and harvesting it twice in a 40-year time horizon, the net benefits of wood for fuel substitution policy scenario are substantially positive.

The conclusion is that the benefits of carbon saving under wood-for-coal substitution policy option are large in the Ukraine and the costs per ton of carbon sequestered are low, if to compare them with the estimates provided for another countries (Van Kooten and Bulte, 2000; Slangen et al, 1997). The calculations show that the implementation of the alternative energy strategy instead of the storage option would increase the costs of carbon uptake. The discounted returns from planting trees are somewhat higher than the opportunity costs of land, but they are inadequate to cover the necessary silvicultural investments and the costs of timber harvesting in the Steppe zone and the Polissja. The costs of timber harvesting are not compensated by the returns in the majority of cases. Wood production activity remains cost-inefficient. Under these conditions, the alternative energy strategy is hardly viable for the Ukraine. Given that the forest law restricts commercial timber cut in the mountainous areas of the Crimea and the Carpathians, the energy option is less realistic for the country than the storage scenario. The strategy is highly applicable only in the Wooded Steppe zone.

6.3.3. Wood products sink option

In this section, I examine the option of timber harvesting and storing of carbon in wood products. Wood substitutes raw materials, is used in construction and in production of goods for households. In this case, wood is a sink of carbon, with the duration of the sink equivalent to the life of the goods. There are various views on the duration of life of wood products. Oxidation rates for wood products are roughly 0.02 per year. There is also an opinion that wood products made from deciduous species release their C back to the atmosphere after 30 years of use, while wood products made from coniferous species release C after 40 years (Van Kooten and Bulte, 2000).

In this study, I assume that wood products release C back to the air after 40 years of storage. As in the wood-for-coal substitution scenario, the rotation ages of poplar and mixed species are that of 20 years, until the growth of the trees slows down. Coniferous trees are considered for harvesting when they reach 40 years of age. The initial cost-benefit analysis does not take into account the production costs of goods made of wood. These are basic assumptions for computing carbon saving estimates for the wood product scenario (Table 6.8.). The social benefits of planting trees for carbon sequestration are high, especially for the zones where poplar is recommended for planting. The product substitution option appears to be comparable with the energy policy scenario. The costs of carbon uptake are low in comparison with carbon uptake costs in the Netherlands (Slangen et. al., 1997). They are 45.9 € per ton in the Polissja, 40.6 € per ton in the Wooded Steppe and 106.2 in the Steppe. The policy appears to be efficient only in the Wooded Steppe where hybrid poplar is suggested for planting.

Table 6.8. Carbon* Saving Estimates Over 40 Years, Wood Product Scenario, tons per ha

	Polissja	Wooded Steppe	Steppe
C uptake savings	18.4	22.2	2.9
C going into wood at harvest	32.4	41.7	3.2
Total C savings	50.8	63.9	6.1
Value of C savings	761.3	959.0	90.2
Net benefits	-74.8	99.0	-539.1

* C is computed in permanent tons.

An important precondition for good results is long lifetime of the products. Another important factors that influence the results are the discount rate employed in the analysis and the time horizon considered in the model. An extension of the period under investigation for the wood product scenario will provide more useful outcomes. With a time horizon longer than 80 years, a continuous process could be shown. Because effects for avoidance of carbon release through the replacement of non-timber materials are repeatable, social benefits under wood product sink scenario in a long-run are expected to be considerably higher than under the strategy of carbon fixation. The storage option is carbon neutral at 0% discount rate, in a long-run, because previously sequestered C is released back to the air through wood decay. Van Kooten and Bulte (2000) have shown that for forests of Western Canada.

When to consider the returns from planting trees and harvesting them for wood production, then as in the previous scenario, the total discounted costs exceed the total discounted returns. However, if to consider benefits of carbon uptake, the afforestation policy to mitigate climate change becomes socially beneficial in the Wooded Steppe.

6.4. Conclusions

Since the 1997 Kyoto Protocol, climate change has become one of the most important environmental policy issues. The Conference of the Parties to the UN FCCC (1997) necessitated agreement on the designation of funding from industries and governments for creating forest plantations. Afforestation of marginal agricultural lands and wastelands has taken an important role as a carbon dioxide reduction policy. The studies on carbon mitigation options have been initiated in a number of countries, including the USA, Canada and some European countries, as the Netherlands.

The ability of forest to uptake carbon depends on tree growth, and therefore, on tree species chosen for planting and on forest management. It also depends on period of timber rotation and, under wood product scenario, on durability of the wood product. In the Ukraine, the costs of carbon uptake, especially under the storage option, are low, 9.5 € per ton (the discount rate for C is 0%) on average for the country. Thus, planting trees to sequester carbon is likely competitive with other means of carbon remove from the air. An important factor that influences the results of simulations is discount rate. Because of time preference, the future carbon reductions decrease in value rapidly. At high discount rates, the value of any amount of carbon sequestered in some 40 years sharply approaches zero. However, even when the time of C sequestration is considered important and the social rate of discount is applied, the results of cost-benefit analysis of the storage policy option are promising for the Wooded Steppe and the Polissja. Forests that capture C quickly, as poplar stands in the Wooded Steppe and poplar stands in mixtures in the Polissja have advantage over the stands in another forestry zones, including spruce stands in the Carpathians.

The storage option is cost-effective means of C uptake in the Polissja and the Wooded Steppe when carbon uptake benefits are discounted at 4%, at the same discount rate, as are discounted costs. When the benefits are discounted at 2%, the storage scenario is economically efficient also in the Carpathians. The most efficient is planting hybrid poplar in the Wooded Steppe, when present value of carbon uptake costs is 4.6 € per ton, if carbon uptake benefits are discounted at 0%. Following the IPCC (2000), carbon savings in this study are presented in permanent tons.

Under wood-for-fuel substitution and wood products sink policy options, when carbon uptake benefits are discounted at 4%, afforestation could be recommended only in the Wooded Steppe, if the only purpose of tree-planting is carbon uptake.[79] When carbon uptake benefits are discounted at 2% and at lower discount rates, these policies also become efficient in the Polissja. The same results stand for the Carpathians. However, harvesting of spruce stands is largely restricted here for environmental reasons. Carbon sequestration in the Steppe proceeds insufficiently, because of low rates of tree growth and due to the fact that when trees reached maturity, the discounted opportunity costs of maintaining forests on agricultural land for the rest of the period appear to be too high. The afforestation of the zone is cost-inefficient, because of

[79] However, in addition to carbon sequestration the afforestation program will provide environmental benefits, as the protection of the lands from erosion (see Chapter 5).

comparatively high agricultural land values, especially, of the marginal land used for wheat production, and because of too low stumpage fees accepted in forestry.

Concerning wood products sink and alternative energy policy options, important factor that influences study results is time horizon considered in the model. For more useful research, the period under investigation has to be substantially extended. Then, a continuous process could be shown. Because effects for avoidance of carbon release through the replacement of non-timber materials are repeatable, social benefits under wood product sink scenario in a long-run are expected to be considerably higher than under the strategy of carbon fixation (a storage option). The storage option is carbon neutral (at 0% discount rate) in a long-run, because previously sequestered C is released back to the air through wood decay.

The study illustrates that wood-for-fuel substitution and wood products options are not viable for the country. The main problem is in cost-inefficiency of wood production. The timber production costs are substantial and are not covered by the returns. In line with the forest law of the Ukraine, which limits harvesting and promotes low stumpage fees, the storage option remains the most feasible.

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7. DISCUSSION AND STUDY OUTCOME

Recently, the concept of sustainable development of forestry has undergone insightful and manifold changes. Starting from a narrow idea of the yield of wood, it has expanded to cover sustainable multi-functional use of forest. Many definitions of sustainability in forestry reflect the variety of ideas. This diversity is even greater if the differing perceptions worldwide are taken into account and varying environments of forestry (economic, social and environmental) are considered. This study provides insights into the theory of sustainability in forestry-in-transition for particular conditions of the Ukraine. Working out the sustainability concept and examining perspectives for sustainable development of forestry during the period of transition from a command-and-control to a market economy is a new scientific effort.

7.1. Initial conditions for the reforms

The demanding purpose of this study necessitates an in-depth analysis of the processes that are going on in the forest sector of the Ukraine's transitional economy. I examine the forest resources, the tenure system, the balance between growth and harvests, silvicultural investment, and potential timber supply. The state of the wood-processing sector and Ukrainian trade in forest products is investigated. The results of the analysis have revealed that while the forest sector has the potential to become an engine for economic growth, the combination of past exploitation and the slow pace of economic reforms are major obstacles to implementing rational forest policies. The state of affairs in forestry with the initial reforms and the changes that have taken place are the focus of Chapter 2.

To offer the road that Ukrainian forestry needs to take the best starting point is to focus on the initial conditions for institutional changes (Macours and Swinnen, 2000). In the Ukraine's forest sector, administrative regulation was huge and it heavily impacted forestry performance. The Ukraine's forestry enterprises used to be under an overall control from the side of Gosplan (the State Planning Committee) via the Ministry with respect to the production, and from the State Bank with respect to financial resources. A number of general economic indicators, e.g. level of output, employment, payment to manpower, costs of production, profitability and financial estimates, were used to establish the annual plan of a forestry enterprise. The Ministry of Forestry[80] co-ordinated plans of enterprises, generalised them into aggregate figures and after an adjustment of the plans by the Gosplan and their verification by the Supreme Council submitted them downwards to the enterprises. The Ministry, and later, the State Committee of Forestry used to be the only institutional body responsible for providing funds and technical assistance, for defining the guidelines and controlling the forest management plans. It was responsible for tree-planting and timber harvesting, fire fighting, non-wood products collection and public access to forests (Pettenella, 2000).

In order to ensure a supply of timber, the government controlled timber procurement. High plans for timber procurement for the purposes of the industrial development accelerated the decline of forest resources, first of all in the Western Ukraine with plentiful forests, where labour was easily mobilised and transport costs were low. Most easily accessible resources, such as those of the Carpathians and the

[80] The Ministry of Forest-Processing Industry, in the Carpathian region.

Polissja, were heavily harvested until 1970s. Extensive development of forestry and mobilisation of inputs to achieve production targets led to forest overcut in these areas.

Under conditions of a command-and-control economy, the main source of incentives for the timber enterprise was the Material Incentives Fund (MIF). It was formed from the profit on condition that the most important indicators, e.g. value of sales, timber production, labour productivity and profitability were achieved at the end of each year. The initial level of the MIF was defined in the plan. However, the planned level of the MIF was increased if the enterprise proposed a counter-plan with higher figures (Ahlander, 1993). Since values of sales were an indicator that most of all influenced the level of MIF, it stimulated quantity-driven behaviour and caused the management to waste, rather than to economise on inputs. The same concerns the output indicator. Because profit remainder was paid into the State budget, profits did not serve as incentives for the enterprises.

The enterprise manager had incentives to maximise costs of production, because if the planned level of profit were high, the planned value of profitability would be set high, and the risk that the enterprise would be unable to fulfill the plan increased. The director was deprived of bonuses if planned fund-forming indicators were not realised, and that practice increased the incentives for avoiding stringent plans. However, it was not wise to exceed the plan's targets by much, as the authorities could then expect an impossibly ambitious goal for the next planning period (Nove, 1982). The incentive to strive for modest plan indicators was also strengthened because the enterprise was functioning under conditions of a permanent shortage. Uncertainty of supply forced an enterprise to keep excess stocks. The combination of supply delays and the need to fulfill plan by a given date caused so-called storming. The instability of norms represented another reason for not aiming too high. Therefore, Kornai's (1980) ideas on the quantity drive used to play a very important role in the forestry sector of the Ukraine. As a result, outputs of by-products and quality of production were insufficient.

Fund-forming indicators did not stimulate sustainable use of the resources. Resource constraints on investment were higher than resource constraint on natural capital. Under those conditions, to fulfill plans the enterprise could find it rational to violate restrictions on forest use, by using the most valuable stock. Also, if labour was scarcer than capital, it would have been induced to substitute capital for labour, to use modern machines instead of obsolete ones (Blandon, 1983). Technical improvements and resource-saving machinery could promote more effective and efficient forest resource use. However, strict focus on fulfilling the plan stimulated the opposite behaviour. Installation of new technology caused disturbances at the enterprise, which threatened plan fulfillment in the short run. Since management was judged by fulfillment of the annual plan and risk-taking was not rewarded, the enterprise was not interested in innovation. This again resulted in overexploitation of the most easily available forests by the way that, for instance, the enterprise avoided an increase in exploitation of broad-leafed trees, as this would require new technology and continued exhaustible use of more valuable stock.

7.2. Changes under transition

Planning and control of timber production in the Ukraine has changed little since the reconstruction of the economy. Among positive features of recent economic changes in forestry is a somewhat increasing self-sufficiency of enterprises. This means that, though forestry enterprises have not been privatised and the role of government remains important, the enterprises have got certain independence in working out and confirming their plans without the involvement of the central authorities. A decrease in number of State orders and directives on production has reduced the focus on output performance. A shift towards decentralised decision-making, economic accounting and self-supporting was introduced. Economic incentives were strengthened. Today, the work of the enterprise besides output is evaluated also by its earned profits, though in most cases, not from the profits received from main forest cut. After the deductions to the budget, certain amount of the profit is left to the enterprise. The income from selling of wood received from thinning, pruning operations, from non-wood production, seeds and from mobilisation of funds from protection and recreational use of forests is coming into the accumulation fund of the forestry enterprise. These are the major changes in the Ukraine's forestry so far.

The forestry enterprises keep receiving government budget to fulfil their task of growing trees, while their activities, regarding timber harvesting are controlled by the government. The stumpage system comprises a rental fee per m^3 that is paid to the allocated tree-felling fund. It is a payment for the raw material paid by the loggers not to the state forest enterprises, but to the State (80%) and the regional (20%) budgets. In sparsely wooded areas of the Ukraine, forestry enterprise is not legitimate to harvest timber (Krott et al, 2000). Consequently, forestry enterprises are focused on budget maximisation rather than on production goals, and without profit maximising objectives from timber production, the enterprises do not have incentives to produce valuable stands. If in forestry[81], there is a closed timber production chain with costs of the production covered on the market the industry will give economic incentives to forestry, which now experiences budget constraints.

Given a European perspective, Nilsson and Shvidenko (1999) suggest restructuring the Ukraine's forest industry as an important step toward sustainable development of the sector. The demand for wood products in the EU is rising with 0.8-2.6% a year, and the EU will remain a high wood cost region (FAO, 1996). Hence, the niche for the Ukraine's forest sector on a European market is its low cost of delivered wood. These authors combined the information with figures on wood fibre costs as a percentage of the average production costs and got an indication on which products the forest sector has to concentrate. Their conclusion is that restructuring of the forest economy should go in the direction of producing products with the highest percentage of wood fibre cost in the average production cost. In order to move in this direction, a lot of existing capacities have to be closed and the remaining are to be focused on saw milling, pulping and production of wood free papers. Then, even under conditions of industrial over-capacity in Europe, the Ukraine, with its reconstructed forest industry could become among price setters in wood production. These are some of the economic considerations, regarding sustainable management of timber as a marketable resource.

7.3. Perspectives for Sustainable Development: Study Results

The perspectives for sustainable development of forestry depend on advance of market changes in the Ukraine's economy and in its forestry sector. A shift towards the concept of weak sustainability corresponds to the requirements of these changes. The weak sustainability concept considers the economic objectives crucial for guaranteeing a necessary and non-declining level of consumption. The concept stipulates that a non-

[81] This applies to the sector that is to supply timber for the economy.

declining level of consumption could be achieved by keeping the aggregate stock of capital constant and allowing for trade-offs between its various components. Sustainability in forestry incorporates economic, environmental and social elements. In economy-in-transition with acute market failures, non-internalised externalities and improper institutions, these dimensions of sustainability are to be addressed separately.

Sustained management of timber is seen as a lower level of hierarchy and a key requirement for sustainable forestry development. The maximum sustainable yield rotation ages for main tree species per zone were defined in Chapter 3. The estimates that account for time span between inputs in production and timber output, and incorporate prices and costs in the models were estimated. The results provided evidence that economic objectives of sustainable forest management are not met in the Ukraine and that the rotation ages in the commercial forests are to be lower. The imposition of a discount rate up to 4% in calculations that lead to decision-making in commercial forestry was another issue considered in Chapter 3.

An economic approach to sustainable forest management is pertinent for forestry-in-transition in view of accumulating financial assets to implement the changes. However, in forestry-in-transition the objectives of a rational profit maximiser should be balanced with social and environmental considerations. Firstly, a properly functioning market is to consider all social and environmental costs and benefits of the production and is to set the prices to guide the use of the resources in a sustainable way. Due to market imperfection, this task is difficult even in the market economies, and it is hardly possible in economy-in-transition where markets do not function properly. Secondly, the idea of maximum sustainable yield is popular in the Ukraine, and time is needed for changing the attitudes of people on the optimal rotation ages in forestry. Thirdly, under present institutional setting the imposition of a positive discount rate in forestry will challenge the forest environment.[82] Finally, purely economic approach is risky when the forest resources remain undervalued.

The conclusion is that though the economic component of sustainability has to be dominant in forestry-in-transition, under conditions when the most important externalities are not internalised, the role of government is important in balancing economic objectives with social and environmental requirements. With further advance of the markets in forestry and when the most important externalities are internalised, governmental regulation will lessen. However, non-marketable public goods of forest possess the properties of non-rivalry and non-excludability, which cause market failure. For that reason, the role of government to control the tenure, management, financing and production of public goods will remain even under conditions of a market economy.

Good governance is essential to promote sustainable development of forestry. The ability of the sector to follow sustainable development path is largely determined by the capacity of its institutions (UNCED, 1992). Recently, three major institutional changes have occurred worldwide:

- a process of globalisation of forest policies and institutions, as an answer to the international community's growing concern on the state of natural resources,
- a search for greater efficiency in public administration,
- a need to enlarge participation in the decision-making process, as an answer to the bureaucratic development of forest institutions and to policy failures due to top-down centralised policies (Pettenella, 2000).

[82] Brukas, et al. (2001) have shown that for forestry of the Baltic States.

These worldwide changes are imposing a revision of the traditional role of forest institutions on a national level.

The analysis provided in Chapter 4 has shown that institutional transformation in forestry has started, though, the rules of the game and the arrangements have not changed significantly. The major tasks that the institutions in economy-in-transition are to pursue: democratisation; participation; economic liberalisation; privatisation; political, administrative and fiscal decentralisation; and restructuring have not been fulfilled. Governance remains an authority: the rules of governance correspond to government laws, organisations are based on governmental structure and the whole system of institutions does not maximise gains for the participants (cf. Shleifer and Vishny 1998). The continuity of institutions is among the reasons why sustainability criteria in Ukrainian forestry are not met. Is forestry on its way to sustainability? How advanced are the changes and what are the remedies for the forest policy reforms? These questions were answered in Chapter 4. The governance failure in the Ukraine has been revealed and the framework of institutional transformation in forestry-in-transition was elaborated. The recommended policy measures for changing the rules of the game towards sustainability include the elimination of the grabbing hand model of governance and the enhancement of social capital, with shifting the mentality of the forest policy actors towards a market economy. The results of the Q-analysis provide insights for understanding the attitudinal diversity of forest policy actors and serve as a meaningful basis for considering the human factor in the process of transition and for advising on policy decisions to promote sustainable forestry development.

While sustainable forest management, seen as sustained yield of timber supply, has been practised in forestry for centuries modern ideas of sustainability are broader in scope, embracing all the goods and services of the forest (Farrell, et al., 2000). There is a shift away from timber production to multiple forest functions of the formation of environment and climate, water balance regulation and the protection of lands from erosion. Planting trees is seen as an instrument to cope with climate change and another environmental problems. The changes in management are required to achieve both production goals and nature protection, and these changes might have significant implications for the long-term development of the forest. This topic has been studied by Nabuurs et al. (2001 and 2002). They used the EFISCEN modelling approach to gain insights into the effects of changing management practices on European forests. The projections were made for the development of forests under four scenarios: (1) business as usual; (2) EFISCEN European timber trend studies (ETTS); (3) maximum sustainable production; and (4) multi-functional management. The simulations were carried out for 30 countries, including the Ukraine. Their conclusions are in line with my results and they indicate a necessity to maintain the national diversity that constitutes European forestry within harmonised forest management strategies.

In Chapter 5, I elaborated the role of forests in the Ukraine and have provided evidence of economic and environmental gains from their expansion. I gave attention to the challenge of planting forests on bare and marginal agricultural lands of the country. Together with the projections on the expanded timber supply from the newly created plantations, I have provided innovative evidence concerning soil protection role of forests. The proposition that high rates of erosion in the country depend on forest cover was put to an empirical test in a regression analysis. The results of the estimations have shown statistically significant negative relationship between soil erosion and forest cover in the country and across zones. Using the results of the analysis on the "elasticities" of erosion with respect to forest cover indicative estimates of soil protection role of forest were computed. Further on, by using a simulation technique and employing cost-benefit analysis, it was revealed that the programme of afforestation for multiple purposes is an economically efficient means to address sustainability in the Ukraine's rural development. Planting trees on bare lands of the Steppe and Wooded Steppe zones and the Carpathians appeared to be efficient even when the discount rate of 4% was employed. The highest gains from afforestation are to be received in the Steppe, where the role of forest to alleviate soil erosion is particularly important.

In Chapter 6, the proposed programme of the establishment of forest plantations was examined as a means for the country to enlarge its contribution to climate stabilisation. Studies on forest biomass accumulation in various types of forests already exist in the Ukraine (Lakida et al., 1995). However, the carbon sequestration function of the Ukraine's forests and the potential carbon uptake benefits of their expansion have not been studied yet sufficiently. I explored the potential of afforestation of bare and marginal agricultural lands as an option for the country to initiate carbon trade negotiations. The chapter presents an assessment of the expansion of carbon uptake through afforestation in the Ukraine and the economics of carbon sink in trees. In addition to simulation of the net benefits from carbon sequestration in trees (in permanent tons), I estimated the net returns from timber harvesting and the use of wood as a carbon sink. I deliberated separately the economics of substitution wood for fossil fuel and have shown that among the investigated alternatives, the storage policy is the most viable carbon saving strategy under specific conditions of forestry-in-transition. Hence, the attempt was made to find out, how the Ukraine's forests and their expansion could help to moderate carbon emissions and what their contribution to climate mitigation strategies could be. Do the Ukraine's forests offer a low-cost opportunity for carbon sequestration? The answer is yes.

The afforestation programme in the Ukraine, particularly in the Wooded Steppe, is a sound climate mitigation policy, because of an essential potential of the newly planted forests to contribute to global carbon uptake and because of availability of lands that are suitable for tree-planting and relatively low afforestation costs. The study also provides evidence that the establishment of forest plantation on CO_2 emissions is not viable for the country without new sources of investment. Therefore, the elaboration of economic technique for receiving credits from the world community for planting trees in the Ukraine is a new challenge for the future. It is important, that in the upcoming studies the problem of afforestation is elaborated in view of timber, soil protection and climate mitigation benefits all at once, and that the gains from various other forest values will also be included in the model.

The conclusion is that the success of the Ukraine's forestry on its way to sustainability depends on the changes that are going on in the country, the changes to a market economy and a democratic society. The analysis on sustainable forestry involve the following major study results:

- it was revealed that a sustainability concept that is to be introduced in forestry-in-transition has to be based on the idea of weak sustainability. The criteria and practical applicability in a transitional economy of the concept of sustainable forestry development were put forward.
- the evidence was provided in support of the ideas that in order to address economic objectives for sustainable forest management the rotation ages in the commercial

forests[83] of the Ukraine are to be lower than the officially stipulated ages, and that the discount rate of up to 4% could be considered in commercial forestry.

- the Comprehensive Forest Zone Classification System has been developed for the Ukraine (Gensiruk and Nizhnik, 1995) by using multi-criteria analysis and was used as a methodological basis for conducting this research. The afforestation programme was assessed on average for the country and according to forestry zones. This concerns all other major study results;
- an innovative approach towards evaluation of soil protection function of forest in the Ukraine and per forestry zone has been proposed on basis of the results of the regression analysis on the elasticities of erosion with respect to forest cover. The soil protection benefits to agriculture of 1 ha of forest appeared to be in the range of 1.6 to 58.2 €;
- the factors that influence sustainable forest policy-making in the Ukraine and across forestry zones were identified on basis of the Q-analysis of attitudinal diversity of the forest policy actors. The Q-methodology involves the sequential application of three sets of statistical procedures: correlation, factor analysis and computation of factor scores;
- the programme of afforestation for multiple purposes has been proposed for the Ukraine and assessed by means of cost-benefit analysis. The results provide evidence that the costs for afforestation will be covered by the returns, at 0% through 4% discount rates on average for the country. The highest gains from afforestation are to be received in the Steppe zone, mainly due to soil protection role of forest. The benefits for alleviation the erosion appeared to be more important than that of expanded timber supply. The NPV of the programme is positive in the Steppe even for the discount rate of 6%.
- by employing LP modelling, the proposed programme was analysed across forestry zones with regard to categories of land to be planted with trees; tree species chosen for planting and management regimes to be applied. In the Steppe, Wooded Steppe and the Carpathinas, bare lands are to be planted with trees, when the discount rate is up to 4%. The highest shadow price of land appeared to be in the Steppe, 245.2 €/ha. Basic silviculture and monoculture plantations appeared to be more rational in each forestry zone.
- the Programme has been assessed as regards to mitigating climate change through analysing three policy scenarios. A new scientific effort was that the estimates of carbon savings were computed in permanent tons. The costs per ton of carbon uptake appeared to be low. Planting trees for carbon sequestration is most promising in the Wooded Steppe, where PV carbon uptake costs are 4.6 €/ton for the storage scenario, when benefits of carbon uptake are discounted at 0%. The storage option appeared to be most viable for the Ukraine in comparison with other policy scenarios.

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Samenvatting

Dit proefschrift richt zich op het ontwikkelen van een theoretische basis en voorstellen voor een duurzame ontwikkeling van de bosbouw in Oekraïne, onder veranderende economische omstandigheden en instituties. De wetenschappelijke waarde ligt in het uitwerken van een multidisciplinaire benadering en het vergroten van de praktische toepasbaarheid van het begrip 'duurzame ontwikkeling van de bosbouw' in een transitieland.

Het begrip duurzaamheid kent economische, sociale en milieucomponenten, die allen van belang voor een duurzame ontwikkeling. In de besluitvorming over sociaal- en milieubeleid wordt zelden aandacht besteed aan economische aspecten, terwijl de sociale- en milieucomponenten vaak over het hoofd worden gezien bij het realiseren van economische doelstellingen. Deze proefschrift richt zich op een brede analyse van duurzaamheid in de bosbouw. Een andere kerngedachte waarop deze studie is gebaseerd, is het principe van meervoudig bosgebruik. Dit beginsel gaat uit van de gedachte dat met hetzelfde bosareaal gelijktijdig een verscheidenheid aan goederen en diensten kan worden geproduceerd en dat zulk bosbeheer de netto waarde van het bos aanzienlijk kan vergroten.

Het proefschrift begint met een probleemanalyse die voor de bosbouwsector van Oekraïne is uitgevoerd. De oorzaak-gevolg-relaties van de in de bosbouw bestaande problemen worden uiteengezet en verklaard. De ideeën over duurzame ontwikkeling van de bosbouw in een transitie-economie worden daarbij onderzocht. Sturen in de richting van duurzaamheid impliceert het vergroten van de productiviteit van het bos, het zorgen voor een adequate houtvoorziening voor de nationale economie, het versterken van de functies van het bos in de bescherming van bodem en water, en het leveren van een bijdrage aan de mondiale vastlegging van kooldioxide. De uitkomsten van de analyse laten zien dat in Oekraïne onvoldoende aandacht wordt besteed aan: de economische aspecten van bosgebruik; de bijdrage van bossen aan klimaatstabiliteit; het institutionele kader van de bosbouw en de noodzaak tot verandering daarvan in verband met de eisen van een economie in transitie. Aangezien de bovengenoemde duurzaamheidscriteria een nadere uitdieping vergen, wordt daaraan in de volgende hoofdstukken van het proefschrift aandacht besteed.

Het begrip duurzaamheid in de bosbouw wordt benaderd vanuit het perspectief van economische ontwikkeling. Dit leidt tot de keuze voor het concept van de 'zwakke' duurzaamheid, waarin uitruil met andere doelstellingen kan plaatsvinden. De economische ontwikkeling, die door marktwerking gestimuleerd wordt, kan een negatieve invloed hebben op bosecosystemen, zorgen voor meer kooldioxide in de atmosfeer of leiden tot ongewenste sociale gevolgen. Degenen die de private baten ontvangen, betalen aan de maatschappij in de meeste gevallen niet de volledige kosten van hun activiteiten, die kunnen resulteren in uitbreiding van erosie, bosdegradatie of ongewenste klimaatverandering. De maatschappelijke baten van het sturen van de ontwikkeling in de richting van duurzaamheid hebben vaak het karakter van publieke goederen, die een veel ruimere spreiding in ruimte en tijd hebben dan de verdeling van de kosten. Marktfalen in de bosbouwsector houdt in belangrijke mate verband met dit verschil tussen private en sociaal-economische kosten. Om die reden moet de rol van de markt in de bosbouw in evenwicht worden gebracht met de functie van de overheid. Publieke voorziening is nodig als coördinatieproblemen het moeilijk maken om marktoplossingen toe te passen. Dit is vooral van belang in een transitie-economie, als markten niet goed functioneren en niet kunnen dienen als een betrouwbaar mechanisme

om te zorgen dat bossen duurzaam worden gebruikt. In hoofdstuk 3 wordt aandacht besteed aan de vraag hoe duurzame bosbouw moet worden geoperationaliseerd onder veranderende economische omstandigheden en welk prikkelmechanisme moet worden gebruikt voor duurzaam bosbeheer in een transitie-economie.

Een belangrijke factor die de ontwikkeling van de bosbouw in de richting van duurzaamheid belemmert is het falen van instituties. Als er sprake is van onzekerheid en een niet goed functionerend rechtssysteem, is het respect voor regelgeving willekeurig en zijn de staatsorganen voor het bos niet in staat tot het handhaven van harde budgetrestricties. Het is nodig om de bosinstellingen aan te passen aan de nieuwe eisen, teneinde de publieke macht over het marktmechanisme te verminderen en de efficiëntie van openbare organen te vergroten. Het is echter moeilijk om de veranderingen te realiseren, omdat ze bijvoorbeeld de ministeriële bureaucratie aantasten. Hoofdstuk 4 laat zien dat bestuurlijke en persoonlijke doelstellingen vaak in tegenspraak zijn met het voldoen aan de eisen van duurzaam bosgebruik. Tezamen met de institutionele omgeving en de institutionele inrichting van het systeem blijkt de menselijke factor van belang te zijn voor het bevorderen van duurzame bosontwikkeling. De diversiteit in attitudes van bosbesluitvormers ten aanzien van duurzaamheid in de bosbouw en van de markteconomie werd onderzocht door gebruik te maken van ‘Q-methodologie’. Dit houdt in dat achtereenvolgens drie statistische procedures worden toegepast: correlatie-analyse, factoranalyse en de berekening van factorscores. De resultaten van de Q-analyse laten zien waarom het bosbeleid van de overheid door de ene groep actoren (of in het ene bosbouwgebied) ongunstig ontvangen wordt en door de andere groep (of in het andere gebied) gunstig. De diversiteit aan attitudes hangt af van de leeftijd en leefomstandigheden van de respondenten, alsmede van hun bekwaamheden, zoals werkervaring en beroep. Door de verschillen in het belang dat bosbeheerders toekennen aan de transitieproblemen komen we achter hun prioriteiten en de factoren die de grootste belemmering vormen voor het transitieproces van de bosbouw naar een markteconomie en in de richting van duurzaamheid.

Omdat de bosbouwsector sterk afhankelijk is van natuurlijk kapitaal, vormt de instandhouding van het gebruik van bosvoorraden een kernelement van zijn duurzame ontwikkeling. Met het oog op de duurzaamheid van het gebruik van het bos als hulpbron hebben we per bosgebied van Oekraïne de vergelijkingen van de groei van de opstanden geschat in relatie tot de leeftijd van de belangrijkste boomsoorten en hebben we de rotatieduur met maximale blijvende opbrengst berekend. Bovendien zijn prijzen, kosten en tijdvoorkeur in de modellen geïncorporeerd en zijn Faustman en Fisher benaderingen van de optimale rotatieduur. Over het algemeen blijken de officieel aanvaarde rotatieperioden voor hout in de commerciële bossen van Oekraïne langer te zijn dan de gesimuleerde optimale rotaties. Eén van de voorgestelde maatregelen voor duurzaam bosbeleid is derhalve het aanpassen van de leeftijden waarop hout geoogst wordt met het oog op economische doelstellingen. Het bebossingsprogramma is een complementaire beleidsmaatregel.

Hoofdstuk 5 richt zich op de aanleg van bossen op braakliggende en marginale landbouwgronden: een bebossingsprogramma voor Oekraïne vanuit multifunctioneel perspectief. De meervoudige functie van bos wordt beperkt tot houtproductie en erosiepreventie. Oekraïne heeft te maken met erosie op circa 35% van het akkerbouw areaal. Zo’n 20 miljoen ha land is onderhevig aan erosie in verschillende gradaties en dit areaal breidt zich in de loop der tijd uit. Erosie is vooral schadelijk in de Karpaten, waar ze windworp en overstromingen veroorzaakt, en in het steppegebied, waar ze het zand in beweging brengt. Naast een verkenning van de toename van de houtproductie uit de nieuw aangelegde bosplantages, wordt ook de bodembeschermingsfuncties van het bos onderzocht. De stelling dat de mate van erosie afhangt van de mate van bebossing is empirisch getest in de vorm van een regressie-analyse. De resultaten van de schattingen tonen een statistisch significant negatief verband tussen erosie en de aanwezigheid van bos, zowel voor Oekraïne als geheel als voor elk van de onderscheiden gebieden. De relaties tussen erosie en bosbedekking zijn gebruikt voor het berekenen van indicatieve schattingen voor de rol van bossen in de bodembescherming. Het vervolg van de verhandeling spitst zich toe op de uitbreiding van het bosareaal in de onderscheiden gebieden van Oekraïne, inclusief de positieve effecten voor de landbouw vanwege erosiepreventie. Door het gebruik van een simulatietechniek en het toepassen van kosten-batenanalyse in combinatie met een LP-model komt naar voren dat het planten van bomen op braakliggende gronden van Oekraïne (behalve in de Polissja) economisch is efficiënt vanuit het oogpunt van houtproductie en erosiepreventie. Voor marginale gronden worden gemengde resultaten verkregen. De resultaten zijn sterk afhankelijk van de gehanteerde disconteringsvoet. Bovendien is er een verschil tussen de berekende baten voor de landbouw en de baten die toevallen aan degene die de bomen plant. Dat is een andere illustratie dat het moeilijk zal zijn om het bebossingsprogramma in praktijk te brengen.

In hoofdstuk 5 wordt bebossing gezien als een beleidsmaatregel die de netto baten van het toegenomen houtaanbod zal vergroten en de bodembeschermingsrol van bossen zal bevorderen. Hoofdstuk 6 bespreekt de mogelijkheden voor het vastleggen van kooldioxide in Oekraïnse bossen via de uitbreiding van bosareaal. Er is een schatting gemaakt van het potentieel voor een verdere groei van de koolstofopname door Oekraïense bossen door middel van uitbreiding van de beboste oppervlakte. De studie besteedt aandacht aan de vestiging van bosplantages, waarvoor drie scenario's voor de beperking van klimaatverandering zijn onderzocht: (1) opslag van koolstof in bossen, (2) koolstofopslag en additionele energiebesparing door brandstof te vervangen door hout (3) koolstofopslag en houtproducten als 'sink'. Bij wijze van eerste benadering is de totale gedisconteerde hoeveelheid koolstof berekend voor de bovengrondse biomassa en het wortelstelsel, bij verschillende disconteringsvoeten. In de meeste gevallen zijn de schattingen van de koolstofbesparingen berekend in 'permanente tonnen'. Dit betekent dat tijdelijke opslag in een 'sink' wordt omgerekend in een permanente ton emissiereductie door het totale aantal 'ton-jaren' koolstof te delen door 50 jaar, wat de laagste omrekeningsfactor is die het IPCC (2000) heeft vastgesteld.

De resultaten van het onderzoek tonen aan dat, terwijl de schattingen van de koolstofopname in grote lijnen vergelijkbaar zijn met die voor andere delen van de wereld, de sociaal-economische kosten per ton koolstofopname in Oekraïne lager zijn dan in landen als Canada, de Verenigde Staten, Nederland en Finland. Ondanks grote ruimtelijke verschillen in de schattingen blijken de resultaten van de kosten-batenanalyse voor het opslagbeleid (scenario 1) veelbelovend te zijn voor alle bosbouwgebieden in Oekraïne bij disconteringsvoeten tussen 0 en 4%. Onder de beleidsopties 'substitutie van hout voor brandstof' (scenario 2) en houtproducten als 'sink' (scenario 3) wordt bebossing met koolstofopname als enige doelstelling alleen aanbevolen voor het 'Beboste Steppe' gebied. Belangrijke factoren die de resultaten beïnvloeden zijn de disconteringsvoet en de tijdshorizon die in de modellen gehanteerd worden. Bij een tijdshorizon van meer dan 80 jaar kan een continue proces worden getoond. Op lange termijn zijn de sociaal-economische baten in het ‘houtproducten’ scenario naar verwachting aanzienlijk hoger dan onder de strategie van alleen koolstofvastlegging in bossen, omdat het in ‘houtproducten’ scenario het vrijkomen van koolstof wordt vermeden door het vervangen van bijvoorbeeld niet-houten materialen. De algemene conclusie van dit hoofdstuk is dat bossen in Oekraïne, met name in het ‘Beboste Steppe’ gebied, een optie bieden voor opslag van koolstof tegen lage kosten en een uitdagend alternatief voor emissiereductie. Het land bezit een duidelijk potentieel om bij te dragen aan de mondiale koolstofopname, gezien de beschikbaarheid van gronden die geschikt zijn voor het planten van bomen, relatief goede omstandigheden voor de groei van bossen en betrekkelijk lage kosten van bebossing.

Hoofdstuk 7 plaatst de resultaten die zijn verkregen tegen de achtergrond van de situatie in Oekraïne en van gelijksoortige onderzoekresultaten. Het proefschrift gaat in op de problemen van verscheidene groepen in de samenleving, waaronder degenen die betrokken zijn bij de bosbouw en de plattelandseconomie, beleidsmakers en managers. Door de aandacht toe te spitsen op strategieën voor duurzame ontwikkeling van de bosbouw draagt het bij aan de oplossing van maatschappelijke problemen: de vergroting van de economische functies van bossen, het voorkómen van de uitputting van bossen als hulpbronnen, en de verbetering van de kwaliteit van het milieu. Dit is belangrijk voor Oekraïne, waar vergaande economische veranderingen plaatsvinden. De doelstelling van het proefschrift was het analyseren van problemen en het zoeken van opties voor een specifieke sector van de economie in een bepaald land. Dit is gedaan voor verscheidene aspecten van de bosbouw in Oekraïne. Zo’n benadering kan ook bruikbaar zijn voor transitie-economieën, die zich eveneens geconfronteerd zien met de uitdaging van vernieuwing op het gebied van economie, instituties en milieu. Door de focus op koolstofvastlegging heeft de studie ook een internationaal belang. Dit betreft vooral het voorgestelde bebossingsprogramma, dat het potentieel van de Oekraïense bossen om bij te dragen aan de mondiale koolstofopname aanzienlijk zal verruimen. Hoofdstuk 7 eindigt met een overzicht van de belangrijkste resultaten die zijn verkregen in dit proefschrift.

Summary

This thesis elaborates a theoretical basis and proposals for sustainable development of Ukrainian forestry under changing economic conditions and institutions. The scientific value of the thesis is mainly its multidisciplinary approach and the increase of the applicability of the concept 'sustainable development of forestry' in a transition economy.

The concept of sustainability has economic, social and environmental components, which are all important for a sustainable development. Economic considerations, though, are often ignored in social and environmental policy decisions, while social and environmental dimensions are often overlooked because of economic goals. This thesis is directed at broad analysis of sustainability in forestry. Another core idea is the principle of multiple forest use. This principle recognises that a variety of goods and services can be produced from the same wooded area and that such forest management can substantially increase net value of forests.

The thesis starts with the problem-analysis carried out for the forest sector of the Ukraine. Cause-effect relations of the major problems existing in forestry are indicated and explained. Ideas on sustainable forestry development under the conditions of the economy-in-transition are examined. Basic thoughts on achieving sustainability targets, as elaborated in this study, are seen as the means for directing forestry development towards sustainability in terms of increasing forest productivity and enlarging timber supply, enhancing soil protective forest functions and the role of forests in global carbon budgeting. The results of the analysis reveal that insufficient attention in the Ukraine is being paid to: economics of forest use, forests' contribution to climate stability, the institutional framework in forestry and the necessity of its transformation according to the requirements of a transition economy. As the above criteria of sustainability require in-depth exploration, they are addressed in the subsequent chapters of the thesis.

The concept of sustainability in forestry is approached from the perspective of economic development. The weak sustainability concept that considers economic objectives crucial and allows for trade-offs between various components of sustainability is pertinent for the forestry-in-transition. As the market promotes economic development, under conditions of non-internalised externalities, it may negatively affect forest ecosystems, bring a lot of carbon dioxide in the air or lead to undesirable social consequences. The recipients of private benefits in most cases do not repay the society in full for the costs of activities, which may result in the expansion of soil erosion or forest degradation. The social gains from directing the development towards sustainability often exist as public goods with much broader spatial and temporal distribution than the distribution of the costs. Market failure in the forest sector is largely related to this discrepancy between private and social costs. For that reason, the role of the market in forestry has to be balanced with the function of the government. Public provision is necessary when co-ordination problems make market solutions difficult to employ. This is particularly important in the transition economy when markets do not function properly and do not serve as a reliable mechanism to ensure that forests are used sustainably. In Chapter 3, two major questions are considered: how can sustainable forestry be realised under the changing economic conditions, and: which incentive mechanism has to be employed for sustainable management of forests in a transition economy?

An important factor that hampers forestry development towards sustainability is the failure of institutions. With uncertainty and when the legal system is not functioning well, respect for regulations is arbitrary, and the state forest agencies are not able to enforce hard budget constraints. It is necessary to adjust forest institutions to the new requirements i.e. to reduce public control of market mechanisms and to increase the efficiency of public agencies. It is, however, difficult to implement the changes, since they affect the ministerial bureaucracy. As is shown in Chapter 4, administrative and personal objectives often conflict with the requirements of sustainable forest use. Together with the institutional environment and institutional arrangements governing the system, the human factor appears to be important for promoting sustainable forestry development. The attitudinal diversity of forest decision-makers on sustainability in forestry and on a market economy is examined by using a Q-methodology approach. This involves the sequential application of three statistical procedures: correlation analysis, factor analysis and the computation of factor scores. The Q-methodology makes it possible to elucidate differences in opinions of forestry actors. The results of the Q-analysis provide insights for understanding why governmental forest policies are unfavourably received by one group of the policy actors, or in one forestry zone, and favourably met by/in another. The attitudinal diversity depends on the age and living conditions of the respondents, and on their competencies, e.g. working experience and occupation. Through the different importance accorded to the problems of transition by the forest managers, we become aware of their priorities and of the factors that most hamper the process of the forestry sector's transition to a market economy and towards sustainability.

The forest sector is heavily dependent on natural capital, so sustained use of forest resources is a core element of its sustainable development. In considering the sustainability of forest resource use, we estimate the equations of the stand growth related to the age of main tree species per forestry zone of the Ukraine and calculate maximum sustainable yield rotation ages. In addition, prices, costs and time preference are incorporated in the models and the Faustman and Fisher estimates on timber rotation ages are computed. Overall, officially accepted timber rotation ages in commercial forests of the Ukraine appear to be longer than simulated optimal rotations. Hence, one of the proposed sustainable forest policy measures is adjusting the ages of timber harvesting with respect to economic objectives. The afforestation programme is another complementary policy measure.

Chapter 5 is focused on creating forest plantations on bare lands and marginal agricultural lands: a multifunctional afforestation programme for the Ukraine is elaborated. The multiple forest functions are limited to wood production and erosion prevention. The Ukraine is faced with erosion on 35% of its arable lands. Some 20 million ha of lands are experiencing various stages of erosion, and erosion is increasing with time. Erosion is especially harmful in the Carpathian Mountains where it causes windthrows and floods, and in the Steppe zone where it results in blowing up sands. Along with exploration of the expanded timber supply from the newly created forest plantations, soil protection forest functions are examined. The proposition that forest cover affects the rates of soil erosion is tested empirically by means of regression analysis. The results of the estimations show a statistically significant negative relationship between soil erosion and forest cover in the Ukraine and across the forestry zones. Using the results of the analysis for the relation between erosion and forest cover, indicative estimates of the soil protection role of the forests are computed.

Further discussion is focused on the proposed expansion of forest cover in the Ukraine, including the positive effects for agriculture due to erosion prevention. Calculations have been made at different levels of detail. By using a simulation technique and employing cost-benefit analysis in combination with LP modelling, it is revealed that for the discount rate of 4%, planting trees on bare lands, except in the Polissja and the Crimea, is an economically efficient means to address wood production and erosion prevention. Results are highly dependent on the relevant discount rate. For marginal agricultural lands mixed results are obtained. Moreover, there is a difference between calculated benefits for agriculture and benefits for the planter of the trees. It seems necessary that e.g. the government balances costs and benefits to provide incentives for the planter of the trees. This is another illustration that it will be difficult to bring an afforestation programme in practice.

While Chapter 5 considers afforestation as a policy measure that will enlarge net benefits from the expanded timber supply and will promote the soil protection role of forests, Chapter 6 discusses opportunities for carbon uptake by the Ukraine's forests, via the expansion of the country's wooded area. The chapter reveals how forests in the Ukraine and their expansion enable to moderate carbon emissions, and what forests' contribution to climate change mitigation strategies could be. The study considers the establishing of forest plantations, and investigates the consequences for climate change mitigation of three scenarios: (1) carbon storage in forests, (2) carbon storage and additional wood-for-fuel substitution (3) carbon storage and additional sink policy for wood products. As a first approximation, the total discounted carbon uptake benefits for the above-ground biomass and the root pool is computed for different discount rates. In most cases, the estimates of carbon savings are calculated in permanent tons. This means that temporary storage in a sink is converted into a permanent ton of emission reduction by dividing total ton-years of carbon by 50 years, which is the lowest conversion factor identified by the IPCC (2000).

The results of the research provide evidence that while the carbon uptake estimates are comparable in the main with those elsewhere in the world, the social-economic costs per ton of carbon uptake are much lower in the Ukraine than in countries such as Canada, the USA, the Netherlands, and Finland. Despite a broad spatial variety of estimates, the results of the cost-benefit analysis of the storage policy (scenario 1) appear to be promising for all forestry zones of the Ukraine, with the discount rates between 0% and 4%. Under wood-for-fuel substitution (scenario 2) and sink policy options for wood products (scenario 3), afforestation for the sole purpose of carbon uptake is recommended only for the Wooded Steppe zone. Important factors that influence the results are the discount rate and the time horizon considered in the models. With a time horizon longer than 80 years, a continuous process could be shown. The effects of avoiding carbon release through the replacement of non-timber materials are repeatable, so social-economic benefits under a wood product sink scenario over the long run are expected to be considerably higher than under the strategy of only carbon fixation in forests. The general conclusion of this chapter is that the Ukraine's forests, particularly in the Wooded Steppe zone, offer a low-cost opportunity for carbon sequestration and a challenging alternative of emissions reduction. The country has quite some potential to contribute to global carbon uptake, because of the availability of lands suitable for tree planting, comparatively good forest-growing conditions and relatively low afforestation costs.

Chapter 7 puts the results obtained in this thesis against the background of the situation in the Ukraine and results obtained in similar research. The thesis addresses the concerns of various groups in society, including those involved in forestry and the rural economy, decision-makers and managers. By focusing attention on strategies for sustainable forestry development, it contributes to solving societal problems: the enlargement of the economic functions of forests, the prevention of the depleting of forest resources, and the improvement of the quality of the environment. This is important for the Ukraine, where far-reaching economic changes are taking place. The purpose of the thesis was to analyse problems and options for a particular sector of the economy in a specific country. That has been done for several aspects of the Ukraine's forestry. It might also be relevant for other economies in transition, which are similarly confronted with the challenge of economic, institutional and environmental innovation. By considering carbon sequestration the study could also be of international interest. This interest primarily concerns the proposed afforestation programme that can substantially expand the Ukraine's potential to contribute to global carbon uptake. Chapter 7 finishes with research results obtained by this thesis.

Резюме (Summary in Ukrainian)

У цій книзі розглянені теоретичні основи та розроблені основні напрями політики сталого розвитку лісового господарства України, що знаходиться у економічних та соціальних умовах перехідного суспільства. Наукова цінність роботи заключається у підсумковому зведені міждисциплінарного досвіду та знань та у розробці шляхів практичного впровадження концепції сталого розвитку лісівництва країни у перехідних умовах. Економічні, соціальні та природоохоронні компоненти концепції сталого розвитку лісового господарства є взаємопов"язаними та однаково важливими. Однак економічний фактор часто ігнорується при прийнятті соціальних та природоохоронних рішень. У свою чергу у соціальному та природоохоронному вимірі економічні цілі також недостатньо враховуються. В роботі представлений комплексний аналіз сталості у лісовому господарстві і розглянені економічні, соціальні та природоохоронні компоненти сталого розвитку у їх взаємодії. Основною ідеєю, на якій базується робота, є принцип багатоцільового використання лісу, усього різноманіття товарів та послуг, що можна отримати з лісової площі, та їх цілеспрямований менеджмент, що дає можливість відчутно збільшити цінність лісових ресурсів.

Робота починається з проведення проблемного аналізу лісового сектора України. У ній відображені та з"ясовані причинно-наслідкові проблеми, що існують у лісівництві. Розглянені основні ідеі сталого розвитку лісового господарства в умовах економіки перехідного періоду. Підвищення продуктивності лісів та збільшення об"ємів постачання деревини для потреб економіки країни, збагачення і збереження грунтів, місце лісів в балансі глобального кругообігу вуглецю, що цільово вивчаються у цій роботі, є основою для розробки основних напрямів сталого розвитку лісового господарства. Результати аналізу показують, що недостатня увага на Україні приділяється: економічному використанню лісів, їх ролі у стабілізації клімату, структурним інститутам у лісовому господарстві та необхідності їх трансформації відповідно з потребами перехідної економіки. У зв"язку з тим, що вищеназвані критерії сталого розвитку потребують глибшого вивчення, вони досліджуються у відповідних главах цієї книги.

У роботі концепція сталості лісового господарства розглядається з точки зору економічного розвитку. Концепція слабкої сталості, що розглядає економічні цілі як основні та такі, що дозволяють здійснювати взаємосприятливий баланс між іншими її компонентами є домінуючою для лісового господарства у перехідний період. В той час як ринок стимулює економічний розвиток, у перехідний період він може негативно впливати на стан лісових екосистем, порушити кліматичний баланс чи призвести до неочікуваних соціальних наслідків. Використувачі приватних лісових ресурсів у більшості випадків не сплачують повну ціну їхньої діяльності, що в свою чергу може призвести до збільшення ерозії грунтів чи до деградації лісів. Соціальні вигоди від впровадження сталості у лісове господарство часто заключаються в суспільних набудках у їх широкому розумінні та мають набагато ширше територіальне та часове розповсюдження, ніж розподіл витрат. Розбіжність між приватними та соціальними витратами і є однією з основних причин недосконалості функціонування ринкових відносин у лісовому секторі. У зв"язку з цим ринкові відносини у лісовому господарстві повинні бути сбалансовані державним регулюванням. Державне втручання необхідно коли виникають проблеми, які не

піддаються вирішенню лише шляхом ринкових відносин. Це особливо стосується економіки перехідного періоду в умовах недосконалих ринкових відносин, які не забеспечують саморегульованності механізму сталості розвитку лісового господарства. В главі 3 розглядаються два основних питання: стосовно впровадження сталого розвитку у лісове господарство в умовах есономічних змін та механізм його стимулювання.

Важливим фактором, що гальмує розвиток лісового господарства у напрямі сталості є недосконаліcть його інститутів. В умовах загальної невизначенності та недосконалості функціонування правової системи дотримання норм та законів є спірним і часто державні лісові підприємства не взмозі витримати фінансові бюджетні обмеження. Нові умови потребують нового підходу зі сторони інститутів лісового господарства, що передбачає зменшення втручання держави у механізм ринкових відносин та підвищення ефективності функціонування державних установ. Однак впровадження таких змін спричиняє протидію зі сторони установчої бюрократії. Як це показано у главі 4 адміністративні та особисті інтереси часто знаходяться у протиріччі з потребами сталого розвитку лісового господарства. Разом з існуючими умовами, порядками та установами, що панують у системі, людський фактор є достатньо важливим для забезпечення сталого розвитку. Різноманіття поглядів працівників лісового господарства на впровадження ринкових відносин та сталий розвиток були дослідженні з використанням підходу Q-методології. Вона включає послідовне використання трьох блоків статистичних досліджень: кореляційного аналізу, факторного аналізу і знаходження факторних показників. Q–методологія дає можливість обгрунтувати розбіжності у поглядах акторів, що задіяні у лісовому господарстві. Результати Q-аналізу дають можливість зрозуміти, чому політика уряду у лісовому господарству підтримується однією групою працівників, чи в одному лісогосподарському регіоні, і відхиляється іншою групою, чи в іншому регіоні. Різноманіття в підходах працівників залежить від їх віку, умов проживання, а також від компетенції, а саме робочого досвіду та службового становища. Враховуючи ступінь важливості різних проблем перехідного періоду, що виявлена у відповідях працівників, була отримана інформація про приорітети сталого розвитку та фактори, які гальмують процес переходу лісового господарства до ринкових відносин.

В зв”язку з тим, що лісовий сектор у значній мірі залежить від природних ресурсів, стале використання лісів є основою сталого розвитку лісового господарства. Стосовно сталості використання лісових ресурсів нами на базі вирахованих рівнянь ходу росту основних лісоутворюючих порід у розрізі лісогосподарських зон були обчислені оптимальні віки рубок дерев при максимальному сталому виходу деревини. В доповнення, ціни, витрати та переваги в часі були враховані в моделі. Таким чином були визначені віки рубок за Фаустманом та Фішером. У більшості випадків офіційно затверджені віки рубок у лісах 2 групи країни виявилися довшими, ніж визначені нами оптимальні віки рубок. Отже одним із запропонованих заходів є корегування віку рубок з урахуванням економічної доцільності. Іншим важливим заходом політики сталого розвитку є програма заліснення

В главі 5 досліджуються питання доцільності заліснення покинутих та низькопродуктивних сільськогосподарських земель. Глава висвітлює багатофукціональне значення лісів та перспективи впровадження програми заліснення. Дослідження багатофункціональної ролі лісів лімітовано розглядом шляхів збільшення об"ємів виробництва деревини та роллю лісів в боротьбі з ерозією грунтів. 35% сільськогосподарських угідь України пошкоджені ерозійними процесами (Національна Академія Наук, 1999). Приблизно 20 мільйонів га землі охоплено ерозією і даний процес поширюється у часі. Ерозія є особливо небезпечною в Карпатському регіоні, де вона є причиною вітровалів та повеней, а також у Степовій зоні, де вона спричиняє поширення сипучих пісків. Ерозія є серйозною проблемою для країни, тому поряд зі збільшенням обсягів постачання деревини з нових заліснених территорій, значна увага у роботі була приділена протиерозійній ролі лісу. За допомогою емпіричного тесту регресійного аналізу досліджено питання залежності поширення ерозії грунтів від лісистості земель. Результат дослідження показав статистично визначенну негативну залежність між ерозією грунтів та лісистістю в Україні та окремо по кожній лісогосподарській зоні. Ця залежність між ерозією грунтів та лісистістю территоріі покладена в основу методики визначення протиерозійної ролі лісів. Подальша дискусія у роботі йде навколо питання збільшення покритої лісом площі за рахунок покинутих земель та малопродуктивних сільськогосподарських угідь. Використовуючи симуляційний підхід, аналіз витрат та прибутків в комбінації з лінійно-програмним моделюванням визначено що лісові насадження на покинутих землях в Україні (за виключенням зони Полісся) є економічно ефективним заходом у збільшенні виробництва деревини та попередження поширенню ерозії грунтів. Для низькопродуктивних сільськогосподарських земель результати не є такими втішними та залежать від показників дисконту. Крім того, спостерігається різниця в отриманих прибутках від сільськогосподарської діяльності та від насадження лісів. Державне регулювання затрат та прибутків у певній мірі могло б стимулююче вплинути на поширення лісовим площ. Це загалом відображає ті труднощі, з якими може зустрітись програма заліснення при її практичному впровадженні.

В той час як глава 5 присв"ячена визначенню чистого прибутку від збільшення постачання деревини та протиерозійної ролі лісів, у главі 6 розглядається програма заліснення стосовно її внеску в запобігання зміни клімату. У главі визначено яким чином українські ліси та їх поширення зменшує вміст вуглецю в атмосфері і яким міг би бути внесок новостворених лісів в запобіганні зміни клімату. Розраховані потенційні можливості збільшення вилучення вуглецю з атмосфери новими лісовими насадженнями. В роботі дослідженні три сценарії можливого внеску нових насаджень в запобігання зміни клімату шляхом: (1)нагромадження вуглецю, (2) спалювання деревини і (3) виробництва продукції з деревини. Як перше наближення, загальний дисконтований об"єм вуглецю в зеленой масі, гілках, стовбурі та в кореневой системі був розрахований при різних показниках дисконту. В більшості випадків розрахунки накопичення вуглецю здійснювались в сталих тонах. Це означає, що об"єми вуглецю, який нагромаджується з часом, переводяться у постійні тони скорочення викидів шляхом ділення загальних тоно-років вуглецю на 50 років, що є найнижчим перевідним показником визначенним IPCC (2000),

Результати дослідження показують, що в той час коли основні показники по поглинанню вуглецю наближаються за величиною до показників визначених в інших країнах світу, питомі соціальні витрати на тону поглиненого вуглецю на Україні є значно нижчими ніж в Канаді, США, Голландії, Фінляндії тощо (Ван

Коотен і Булте, 2000; Набурс та інші, 1999). Не дивлячись на широкий спектр у розподілі показників, результати аналізу витрат і прибутків за сценарієм нагромадження вуглецю (1) виявили його доцільність для усіх лісогосподарських зон України коли були задіяні коефіцієнти дисконтування від 0% до 4%. За сценарієм спалювання деревини (2) і виробництві продукції з деревини, (сценарій 3), насаджувати ліс лише з метою накопичення вуглецю, рекомендуються тільки у Лісостеповій зоні. При цьому коефіцієнт дисконтування та час спостережень є важливими факторами, що впливають на результати моделювання. Шляхом продовженням часу спостережень більш ніж 80 років може бути засвідчена тривалість даного процесу. Тому що процес по запобіганню звільнення вуглецю шляхом заміни недеревних матеріалів деревиною повторюється у часі, соціальний ефект за сценарієм 3 (виробництво продукції з деревини) за тривалий час буде значно більшим ніж за сценарієм 1 (нагромадження вуглецю у лісостанах). Загальний висновок цієї глави є те, що нові лісові насадження, особливо у Лісостеповій зоні України, являються низьковитратним засобом поглинання вуглецю і привабливою альтернативою скорочення викидів у атмосферу. Наявність у країні земельних угідь які доцільно залісити, порівняно сприятливі умови лісозростання та відносно низькі соціальні витрати по залісненню свідчать про те, що Україна має визначні потенційні можливості додати свій внесок у запобігання зміни клімату.

У главі 7 подаються та дискутуються основні висновки проведенної роботи. Базуючись на міждисциплінарних аспектах дослідження, робота висвітлює проблеми різноманітних груп суспільства, включаючи тих хто працює у галузі лісового господарства та аграрної політики, управлінців та менеджерів, представників природоохоронних організацій та громадськості. Фокусуючи основну увагу на стратегії сталості розвитку лісового господарства, робота розглядає проблеми розширення економічної функції лісів, запобігання виснаження лісових ресурсів та покращення стану природного середовища. Для України, де відбуваються докорінні економічні зміни, ці питання є виключно важливими. Основною метою роботи є вирішення проблем в окремому секторі економіки в конкретній країні. Це фактично досягнуто з точки зору розвитку різносторонніх аспектів лісового господарства України. Передбачається також певна користність її результатів для економік інших країн з аналогічними умовами перехідного періоду, що стоять перед необхідністю проведення економічних, інституційних та природоохоронних змін. Дослідження потенційних можливостей збільшення вилучення вуглецю з атмосфери може мати певний міжнародний інтерес. Це в більшій мірі стосується запропонованої програми заліснення, що значно розширює потенціал українських лісів, в тому числі стосовно їх внеску у глобальне запобігання зміни клімату.

CURRICULUM VITAE

Maria Nijnik was born in 1956 in Lviv, the Ukraine. She graduated Ukrainian University of Forestry and Wood Technology with the Diploma of Engineer with Distinction in Wood-Processing Technology and in Furniture Designing. With time, the focus of her scientific interests has been gradually shifting from Engineering towards Economics and the Environment. In 1984, Maria received her first PhD[84] in Economics at the Institute of Economics, Ukrainian National Academy of Sciences. She worked as a researcher and later, as a senior scientific officer at the National Academy of Sciences (Kyiv and Lviv). In 1991-1994, she was an associate professor of the Ukrainian State University. Her list of publications includes 68 items, published on basis of her previous studies and also on basis of the results of her current research. In 1995, Maria Nijnik received a MSc in Environmental Policy and Management, in the Netherlands. In 1995-2000, she was a visiting researcher at the Institute for Environmental Studies (IVM), Free University of Amsterdam (VU). In 1999, Maria Nijnik received the Diploma of the Netherlands Network of General and Quantitative Economics. She also fulfilled the requirements of the Mansholt Graduate School of Social Sciences. Maria Nijnik developed her PhD in the Netherlands, working with the Group of Agricultural Economics and Rural Policy, the University of Wageningen. Presently, she receives a fellowship of the Mansholt Institute and continues working with the Group.

[84] The study was on economic and environmental problems of using forests of the Western Unkraine for toursim and recreation.

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