HAZARDOUS WASTE INFLUENCE ON LATVIAN FORESTRY ECONOMIC RESULTS

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Abstract

Forestry and development of sustainable forest management system today are becoming one of the most important socio-economic and environmental issues world-wide. For Latvia, where forests are one of the most important natural resource, forestry management is one of the essential issues in economics. Ecosystems of forests are under continuously impact from substantial natural and anthropogenic influence. One of the most important aspects of forestry economical results is forest pollution with waste, inter alia, hazardous waste so as heavy metals and pesticides. In Latvia are actual so problems as illegal dumping in forests, what being indicatively reflected on the quality of natural resources and labor force, influences national well-being in general and particularly economical indexes of forestry. For rationalization of Latvian national economy regulation it's worth to review impact of hazardous waste generation and management on forestry economical results, considering as forests economical input, as ecological benefits, which directly ensure conditions for sustainable economy development. Assuming that there exists direct relationship between hazardous waste amount and forestry benefits, is supposed that it's possible to to have an impact on economical results, basing on so indicators as level of forests quality and rate of potential hazardous waste generators in national economy. Formulation of methodic approach for national economy regulation basing on diversification of gaining on production, what results in hazardous waste generation, manufacturing and exploitation and forestry development in intensive way, restricting hazardous waste flow is the goal of the stage of the research. The results of hazardous waste economical impact on forestry results measurement could be putted into practice in process of making efficient decision about national economy structure and possibilities of improvement economic indexes.

Key words: forestry, hazardous waste management, economic benefits, ecological efficiency

Introduction

For Latvia, where forests are one of the most important natural resources, forestry is one of the essential issues in economics. Forests are a characteristic element of Latvian landscape. Latvia has one of the richest forest resources in Europe covering more than 50.4% of the country (1.5 times higher than the world average) with a total of 648 million cubic meters of growing stock. Accordingly, forests play a significant role in the development of rural areas and for recreational purposes [1].

Ecosystems of forests are under continuously impact from substantial natural and anthropogenic influence. One of the most important factors affecting forestry economical input is forest pollution with waste, inter alia, hazardous waste so as heavy metals and pesticides. In Latvia so problems as illegal dumping, inter alia, dumping of hazardous waste, in forests are actual still, what being indicatively reflected on the quality of natural resources and labor force influences national well-being.

Formulation of methodic approach for national economy regulation basing on diversification of gaining on production, what results in hazardous waste generation, manufacturing and exploitation and forestry development in intensive way, restricting hazardous waste flow is the goal of the stage of the research the results of which are creation of demonstrative models and formulation of parameters for hazardous waste economical impact on forestry measurement and forestry ecological benfits transformation into economical value. Methods of systematic analysis, logics and synthesis were used in this research.

The results of hazardous waste impact economical measurement could be putted into practice in process of making efficient decision about national economy structure and possibilities of improvement economic indexes.

1. Economical importance of forest sector in Latvia's Economy

Forest in Latvia is an ecologically stable ecosystem that secures a balanced maintenance of the environment. Latvia's forests and woodlands covered 2.9 million ha (7 million acres), or approximately 47% of the total land area in 2000 (up from 24.7% in 1923). Before World War II (1939–45), the timber and paper industries accounted for 29% of employment; by 1990, the number had fallen to 9%. In 1939,

the timber industry contributed 53.5% to total exports; in 1990, wood and paper exports accounted for 2.2% of total exports. The timber cut in 2000 was 14,488,000 m³ (511 million cu ft), with 12% used as fuel wood. Production amounts in 2000 included: sawn wood, 4,030,000 m³ (142 million cu ft); particleboard, 102,000 cu m (3.6 million cu ft); plywood, 156,000 cu m (5.5 million cu ft); and paper and paperboard, 16,000 tons. Exports of forest products amounted to $625.9 million in 2000 . In that way, forest industry takes an important position in economics, providing wood products (Fig. 1) and insuring value-added development (Fig. 2) [2, 3].

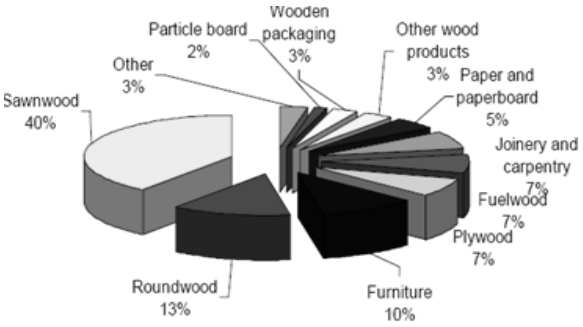

Fig. 1. Forest industry input in Latvian economics [4]

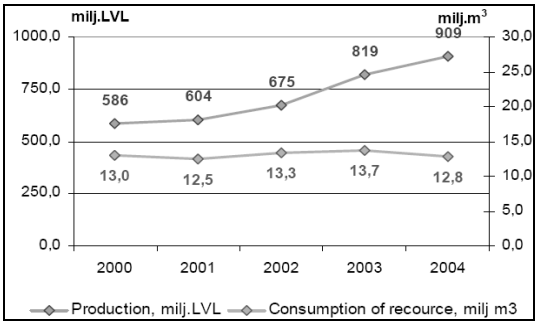

Fig. 2. Value-added development of forestry dynamics in Latvia from 2000 till 2004 year [4]

Forest sector export in Latvia in the first half of 2008 dropped by 12% in terms of money. The most significant impact was left by the rapid decrease in sawnwood export, and there was a decrease in the income by 35,9%. Since sawnwood export till now had the biggest share in the export of the sector (approximately 1/3 from total income), the decrease reduced the performance indicators of the sector [5].

Besides of direct economical importance of forest sector can be distingueshed majority of ecological factors wich make forests by one of instruments of economical indicators regulator. For example, forests, having huge sanitary and hygienic and curative value, because of natural forest air contains more than 300 kinds of various chemical compounds. As well forest, especially coniferous trees, allocates fitoncids — the flying substances with bactericidal properties, which kill pathogenic microbes and well influence nervous system, strengthen impellent and secretion functions of a gastroenteric path, improve metabolism and stimulate action of the heart. Fitoncids of aspen tree bud, Antony apples, eucalyptus destroy flu virus. Oak leaves destroy bacteria of abdominal typhus and a dysentery [6].

Besides, transforming atmospheric pollution, especially gaseous, actively absorb industrial pollution, in particular dust and hydrocarbons, forests make favorable conditions for sustainable living and economy. As well it's possible to distinguish following basic directions of use of forests in economic purposes: a food source, the energy source, the building material, raw materials for manufacture [6].

Ecological input, which produce forest as regulator of natural processes by photosynthesis, water, oxygenous cycle and lithosphere regulator, as well as influencing people health, must be transformed in economical values. Damaging forests national economy lose considerable part of NDP, what implicitly expresses in total resource market aggravation.

In that way forest sectors impact results exist as direct benefits – economical, as in indirect - ecological benefits.

Ecological benefits is possible to define as input of forests, what expresses as benefits what society obtain by exploiting forests natural resources and favours.

Economical benefits are financially evaluated input of forests by exploiting forests natural resources and favours as instruments of economy.

Ecological benefits is possible to appreciate through costs of lost possibility of exploiting forests natural resources and favours in result of forest damage.

2. Hazardous waste influence on Latvian forestry

One of major factors affecting the function of ecosystems is environmental pollution and flows of nutrients from the atmosphere. The

most important factors influencing forests vitality is pollution with hazardous waste.

The organic layer of forest soils accumulates atmospheric pollution over a long-term period. The impact of environmental pollution on forest soils has decreased during the past ten years, and the distributions of concentrations of metals have significantly changed. The concentrations of Cu, Cd, Pb, Zn, V, Ni, Cr, Fe Ca, Mg and K were determined in the organic soil layer of pine forests in Latvia. The concentrations were expressed on a mass, volume and surface area basis [7].

It's worth to notice, that hazardous waste are connected with forestry in two aspects:

1. forestry is the source of hazardous waste;
2. hazardous waste from forests internal and external sources are the cause of forests pollution.

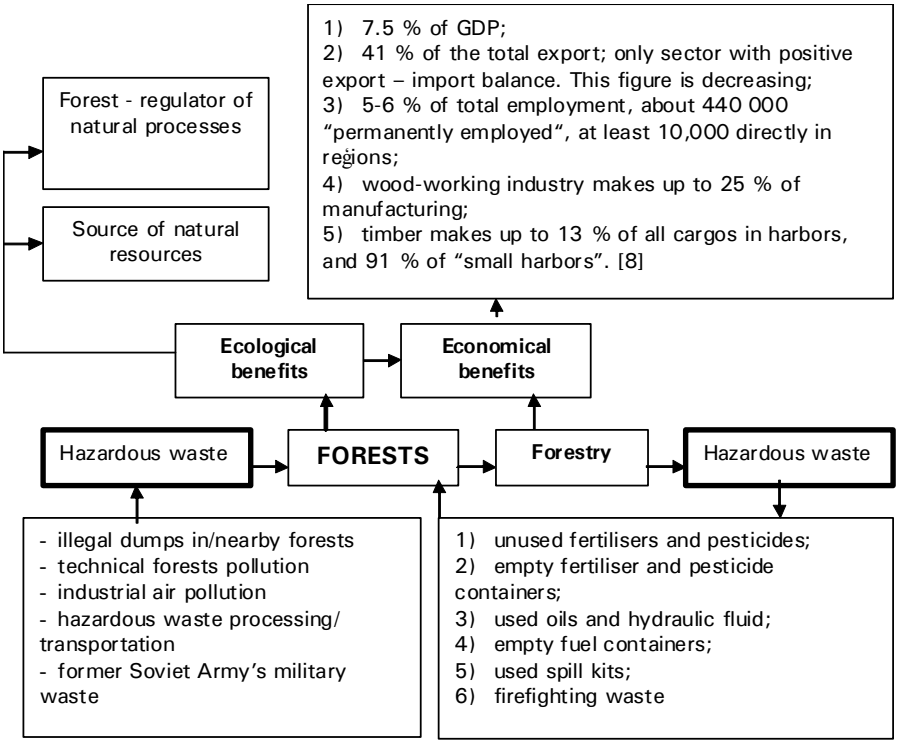

Fig. 3. Model of reciprocity between hazardous waste flow and forestry development

It's important to notice reciprocity between hazardous waste amount and forestry development (Fig. 3). The relationship is dual: hazardous waste influence forest quality and forestry generate hazardous waste what, in turn, effect forests, as well as other related sector and sustainable living in wholl.

Notable sources of hazardous waste pollution are illegal dumps in or nearby forests, the issue of what is not managed in appropriate way still. Besides, harzarous waste flow into forests is providing by diffrent technical works. So, raw materials for construction (limestone, gypsum, clay, sand etc.) and peat are the main geological resources of Latvia. Only 20 percent of resource extraction sites are managed in accordance with environmental requirements. About 17 percent of the quarries have unmanaged waste dumps [9].

Also considering that byproducts of enterprises majority are hazardous waste, it's obviously that conditions of forest resources are influenced by industrial sector in process of economic activity.

Legislating for extensive expansion of waste components by the way of contacting with environment, is obvious, that important factor affecting the function of ecosystems is environmental pollution and flows of nutrients from the atmosphere. Accordingly, inevitable threat for forests health is presented as by hazardous waste sources which situated exactly in forests/nearby forests, as distant from it. So, condition of forest resources are affected in great scale. Depending on source location and category of danger haz-

ardous waste of this group could influence forests health in various degrees:

1. sources, what present potential threath for forests healts;
2. sources, what present inevitable threath for forests healts;
3. sources, what present improbable threath for forests healts (Fig. 4).

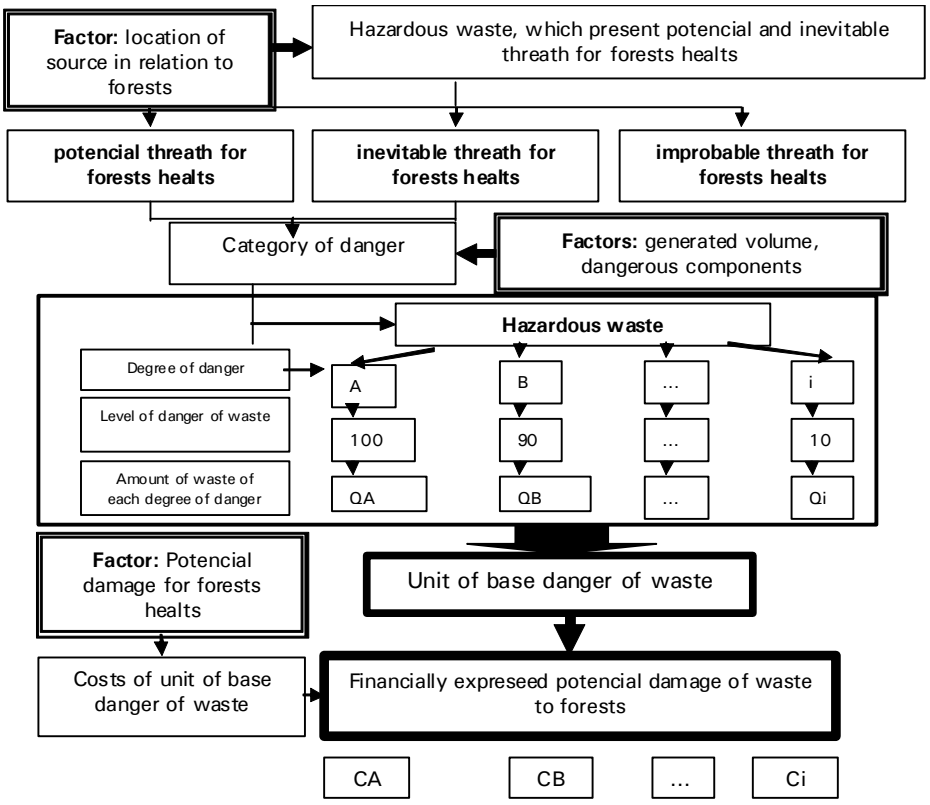

Fig. 4. The model of evaluation hazardous waste potencial economical damage for forests healts

The most serious environmental and economic damage was done to agriculture and forest lands by the former Soviet Army's military firing grounds, airfields, rocket bases, fillingstations and fuel depots. The Army had firing grounds for every kind of weapon in Latvian territory. The buildings in these areas are not usually suitable for conversion to civil use. The largest Soviet military firing range and aviation targets covered 24 500 hectares of farmland and forest at Zvarde. Diffuse contaminants such as aircraft fuel, burning wastes, and explosives have rendered the soil unusable [9].

In turn, forestry operations can produce a number of different hazardous materials (Fig.3). Assuing that costs flow connected with forests damage by hazardous waste wouldn't be generated, hazardous waste influence could be expressed as *reduction of forests potencial economical benefits* (Fig. 5).

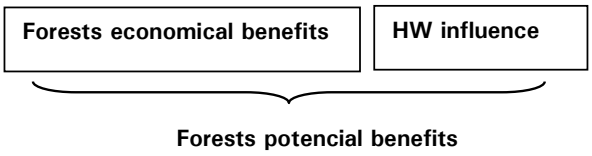

Fig. 5. Hazardous waste influence on forests sector profitableness

Evaluation of forest ecological benefits, as well as ecological forests damage by hazardous waste influence are significant questions. In the basis of economical evaluation is establishing of forest ecological benefits evaluation standards and, accordingly, upbuilding economic accountment system of forest ecological benefits and forests damage by hazardous waste.

Transforming all possible costs into potential gainings we can formulate financially expressed forests ecological benefits as the sum of current and potential costs and losses. Evaluat-

ing forests damage by hazardous waste, it's necessary to take into account, that whatever pollutant provokes not only losses, but also costs. As well losses, costs could be current and potential (Fig. 6).

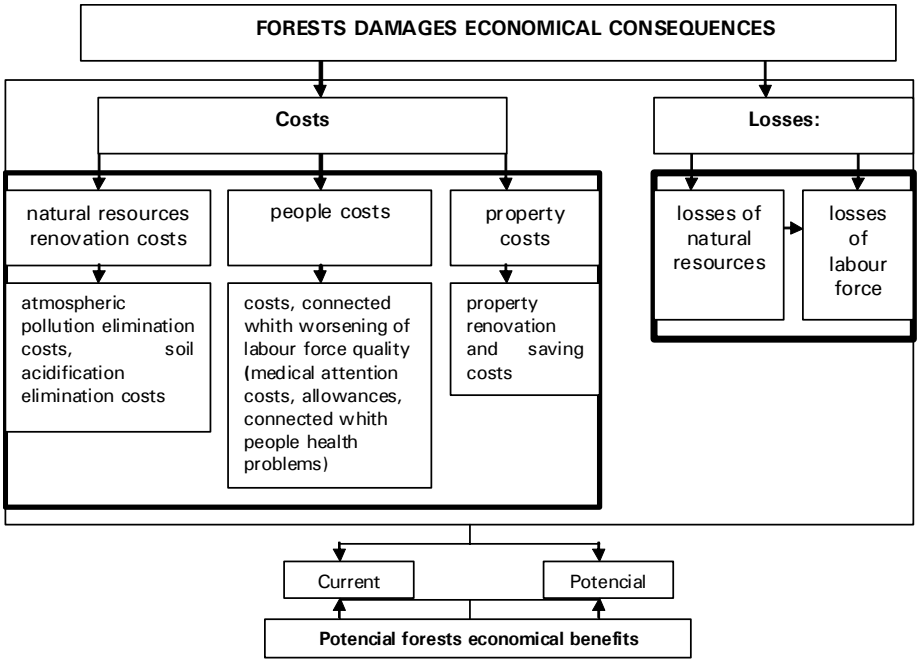

Fig. 6. The model of forests damage by hazardous waste economical consequences

The rate of hazardous waste produced economical consequences, which is exactly is related to forests damage must be evaluated by special coefficients, taking into account factors:

1. location of source in relation to forests;
2. category of waste danger.

So, in base of economical benefits evaluation are costs and losses, connected with forest damage by hazardous waste. In other words we must evaluate benefits which would be taken away in case of forest damage.

3. Model of national economy regulation on base of reciprocity between hazardous waste flow and forestry development

In case of Latvian state, taking into account forestry great significance, the issue of selection of optimal national economy development strategy could be based on diversity of hazardous waste rate, searching for optimal proportion between producing and exploiting of hazardous production amount and forests protection. This proposal could be defined by **hypothesis:** Latvian foresty economical benefit is function of generated hazardous waste flow, what is described by formula (1).

$$B(F) = f(qHW), \quad (1)$$

where B(F) - forestry economical benefits, EUR;
qHW - volume of hazardous waste, kg.

This hypothesis is practically demonstrable by tendency of forestry specific weight in GDP in dependence of generated hazardous waste volume. It's necessary to take into consideration, that forestries economical indexes are effected as by generated hazardous waste volumes in current, as in previous periods of time. It explains a little grouth of forestry input during increase of hazardous waste volume (Fig. 7).

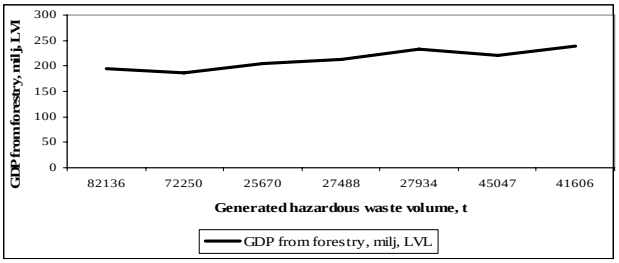

Fig. 7. Tendency of forestry specific weight in GDP in dependence of generated hazardous waste volume [9]

Regulating hazardous waste generated amount we can regulate GDP. The determinant is

the issue: what is more profitable - producing and exploiting of production what rezults in hazardous waste generation or abandonment and restriction of hazardous waste producing by different ways (integration of less hazardous technologies, restrictions and bans) and gaining on foresry. To answer this question must be evaluated not only forestry input and forests damage by hazardous waste, but also benefits from hazardous production exploiting and costs of technologies modification, as well as losses from restrictions and bans.

There must be compared forests economical benefits in different levels of hazardous waste influence and losses in order to make a choise of optimal national economy development strategy. Basing on strategy must be selected appropriated instruments for regulation.

Optimal model for state economical policy development is in the maximal locus of total economics effetiveness, what confirm to upper possible limit of forest quality (Fig. 8).

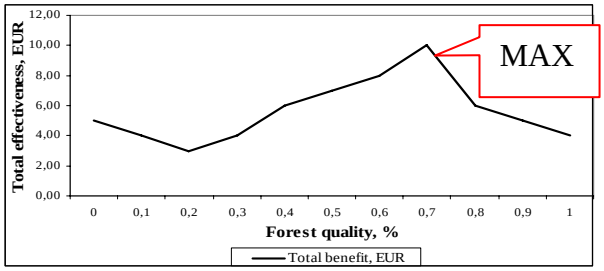

Fig. 8. Relation between total effectiveness and forest quality level [9]

Forest quality is index, appreciated basing on system of indicators, evaluating so areas as development, maintenance and improvement of forest resources including their contribution to global carbon cycles, conservation and enhancement of biological diversity in forest ecosystems, maintenance and enhancement of forest ecosystem health, vitality and integrity, maintenance and enhancement of productive functions of forests and other wooded lands, maintenance and improvement of environmental and conservation functions of forests and other wooded lands and combating land degradation/desertification.

To identical indicators of forests quality there can correspond different levels of total economical effectiveness that are assumed benefits from hazardous production exploitation and benefits from forests sector. Accordingly, the choose of optimal model for state economical policy development leades to total benefts, that includes as forestry economical and ecological benefits, as benefits of generation of hazardous waste, maximization.

$$\begin{cases} TB = B(F) + B(HW) -> \max \\ B(F) = f[Q(F)] \\ Q(F) = f(qHW) \\ B(HW) = f[B(HP), I(HW)] \\ B(HP) = f[(qHP), P(HP)] \\ P(HP) = const \\ >= Q(F), qHP >= 0 \end{cases} , \quad (2)$$

where TB - total benefits, EUR;
B(HW) - benefits of generation of hazardous waste, EUR;
Q(F)- forests quality , %;
B(HP) - benefits of exploiting/producing hazardous production, EUR;
$I(HW)$ - incomes from hazardous waste, EUR;
qHP - rate of hazardous production, %;
P(HP)- price of hazardous production , EUR.

Benefits are repsresented as diference between economical incomes and costs, connected with economical activities.

$$B = I - C , \quad (3)$$

where B – benefits, EUR;
I – incomes of sector, EUR;
C–current and potencial costs, connected with sector of economical activity, EUR.

For more understanding about models, benefits are assembled into components in formulas (4) – (13) below. All component are evaluated only in relationship with forestry. Costs connected with forestry include losses in result of abandonment or restriction of hazardous production exploitation.

$$I(F) = I(F)econ + I(F)ecol, \quad (4)$$

where I(F) – incomes from forestry, EUR;
I(F)econ – forestry economical incomes, EUR;
I(F)ecol - forestry ecological incomes, EUR;

$$I(F)econ = P(FP) + I(FP), \quad (5)$$

where P(FP) – price of forestry production, EUR;
I(FP) – incomes from forestry production exploiting , EUR;

$$I(F)ecol = I(LF) + I(NR), \quad (6)$$

where I(F)ecol - forestry ecological incomes, EUR;
I(LF) - financially expressed incomes from healthy labour fource, EUR;
I(NR) - financially expressed incomes from healthy natural resources, EUR.

As people health of definite generation more or less depends on previous generation health and influence operational capability of next generation, we can suppose, that economical incomes have the same relation. So, evaluating potential incomes from labor force we must include both factors.

$$I(LF) = f[I(LF)prev, I(LF)next], \quad (7)$$

where I(LF)prev – incomes from labour force of previous generation, EUR;
I(LF)next - incomes from labour force of next generation, EUR.

$$C(F) = Cmain + Cmanag\_FHW + L\_ab/restr, \quad (8)$$

where C(F) - costs connected with forestry, EUR;
Cmain - forests maintenance costs, EUR;
Cmanag_FHW - forestry hazardous waste management costs, EUR;
L_ab/restr - losses in result of abandonment or restriction of HW production producing, EUR.

Incomes from hazardous waste generation include potential losses in forestry.

$$I(HW) = I(HW)reg + I(HP), \quad (9)$$

where I(HW) - incomes from HW, EUR;
I(HW)reg - incomes from hazarous waste regeneration and exploiting as alternative source of energy, EUR;
I(HP) - incomes from exploiting/realization hazardous production in current volumes, EUR;

$$C(HW) = L(LF) + L(NR) + C(HW)reg + L\_dam, \quad (10)$$

where C(HW) – costs connected with hazardous waste generation, EUR;
L(LF) – losses connected with labour fource worsening, EUR;
C(NR) - losses connected with natural resources worsening, EUR;
C(HW)reg - costs connected with hazarous waste regeneration and exploiting as alternative source of energy, EUR;
L_dam - current losses connected with forests natural resources damage, EUR.

$$L(LF) = C\_med + C\_allow + L\_phys, \quad (11)$$

where C_med - current and potencial medical attention costs, EUR;
C_allow - current and potencial allowances, connected with people health problems, EUR;
L_phys - current and potencial physical losses of labour fource, EUR.

$$L(NR) = L\_atm.pol + L\_s.acid + L\_anim + C\_elim, \quad (12)$$

where L(NR) – losses connected with natural resources worsening, EUR;
L_atm.pol - losses connected with atmospheric pollution, EUR;
L_s.acid - losses connected with soil acidification, EUR;
L_anim - losses connected with disappearance of animals kinds, EUR;
C_elim - pollution elimination costs, EUR.

$$L\_dam = L\_fs + L\_es + L\_rms, \quad (13)$$

where L_fs - food source diminishing/losses, EUR;
L_es - energy source diminishing/losses, EUR;
L_rms - raw materials for manufacture source diminishing/losses, EUR.

Summarizing and evaluating information about hazardous waste economical influence on Latvian forests, as well as studying changes of forestry input into Latvian national economy depending on hazardous waste amount in length of time is possible to achieve optimal economics results in existent circumstances.

Conclusion

Created model of national economy regulation, based on calculation of economical input and output of hazardous production manufacturing and exploitation and comparison it with forestry economical results in different levels of potential influence of hazardous substances from forestry and other sectors of economical activity, make possible to define economical role of forests ecosystems in Latvian national economy, as well as sketch scenario for efficient working out and development of sustainable forest management system.

According to model for regulation of main Latvian economics indexes is necessary to provide limitation of external forests pollution, as well as have to manufacture cost effective and reliable high performance enviromentally friendly forestry equipment which let to reduce internal forests pollution.

All conmopents of optimization model are presented in form of dependency functions, which factors could be specified in result of actual tendencies of main components in definite periodds of time research.

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