ENVIRONMENTALLY SUSTAINABLE TECHNOLOGIES AND ENVIRONMENTAL QUALITY INDICATORS
EKOLOĢISKI ILGTSPĒJĪGAS TEHNOLOĢIJAS UN VIDES KVALITĀTES INDIKATORI

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Abstract. *Despite the fact that environmental indicators are investigated for long time the solving of indicators problems is far of completion yet. Paper discusses the results of investigation environmental indicators in conformity with quality of environmentally sound technologies and their impact on man's life quality.*

As a result of investigations three groups of indicators were worked up:

1) *for environment quality in cities – anthropogenic pressure indicators on atmosphere, water and earth,*
2) *for estimation of technologies, containing information about useful exploited natural resources and utilization waste products,*
3) *for assessment mutual changes of environment quality and man's living quality.*

The paper offers equations which characterize possibilities for development of industry on the principles of sustainable development.

The quality of the environment usually is estimated by variable indicators. The type of indicators and their nature depends on the aims they are used for and objects they must to characterize.

For example, three groups of indicators elaborated by the OECD which are widely recognized – "Pressure", "State" and "Response" were accepted by Baltic States for their environment reports since 1998. [1]

But these indicators cannot be used for more local and specific territories – such as separate ecosystems or urbanosystems. On the other hand the quality of natural ecosystem is connected with energetical and dynamic properties of ecosystem such as growth of biomass, biodiversity, laws of succession etc.

The quality of natural resources depends on intensity of their exploiting and renewable parameters and there must be different indicators.

In conformity with artificial urban system there are other parameters used for assessment of environment quality in cities. As the central object in the urban systems are population of citizens the main general indicator of environment quality must be people's health parameters.[2] Nevertheless this indicator is postindicator – it is too late to control quality of environment when human life is in danger. It means that in cities must be controlled main factors possible to exert influence on the health of citizens.

Urban indicators must include such factors as:

a) the level of industrial development and ecological safety of plants;
b) the flows of vehicles, and their density and intensity;
c) the number and density of population and the distribution of buildings in city;
d) the quantity and quality of recreation territories in city and the accessibility of relaxation zones out of the city;
e) climatic, geographical and geological parameters of territory;
f) the water resources and kinds of the reservoirs;
g) the quantity and composition of wastes and systems of their disposal and treatment technology.

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All these factors has double influence on the man – physically chemical (pollution) and psychical (distress and discomfort). Straight physical and chemical influence is connected with air, water, earth and food quality. It is well known that estimation at air, water and soil quality may be accomplished through concentration of pollutants in these substances.

However the parameters of concentration of contaminants do not contain information about reasons of the pollution. The concentration of matter in air, for example, depends on meteorological conditions, relief of territory, geological features and other factors and not only on amount quality of pollutants.

It means that maximal level of allowed concentration of matter can be achieved with the small quantity of pollutants and at the some time it is possible that large quantities of pollutants will not give such effect.

But if we consider that the main way to eliminate pollution of nature and protect environment is to reduce and to stop in creating pollutants it is necessary to use quantity of total emissions of pollutants as a main indicator of the environmentally sound technology.

So environment quality in the cities may be estimated with the next indicators [3, 4].

1. Anthropogenic pressure indicator on atmosphere (air) I_g: depends on density of population in city B (population per 1 km^2) and quantity of emissions in air on the area 1 km^2 –M_s(kg/ km^2). M_s must be calculated for each pollutant independent and then summarized taking into account the danger coefficient of matter D_s.

$$I_g = kB\sum_j (M_{sj}/D_s) \qquad (1)$$

Where: k – special coefficient on geological and climate conditions (between 1 – 6).

2. Anthropogenic pressure indicator on the surface of water reservoirs I_h must be calculated taking into account the quantity of pollutants M_h discharged in the water

$$I_h = \sum_j (M_{hj}/D_h \sum (K_{fj} V_j)) \qquad (2)$$

Where: $K_f = 1/R_f E_f$ – stability factor of water reservoirs (0,1 – 1,0)

R_f – factor of resistivity

E_f – elasticity factor

3. Anthropogenic pressure indicator on the earth surface I_T must be estimated taking into account the area of degraded territories S_{degr} and quantity of the solid pollutants M_T

$$I_T = \sum_j (D_{ej} M_{Tj}) \Big/ \sum_j (S_{degr} S_{ter}) \qquad (3)$$

Where: D_{ej} – danger coefficient of pollutants;

S_{ter} – the total square of cities territory

The paradigm of environmentally sound technology is clearly formulated in UN program "Sustainable Development – Agenda–21", Chapter 34.

These technologies includes not only tasks for elimination of pollution, but also using all resources in a more sustainable manner and producing the products with less influence on the environment and nature during their exploiting and after exploiting – so called ecologically safe life – cycle of products [5].

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These technologies – ecotechnologies must be estimated by another groups of indicators:

1. Capacity of materials (resources) M– total quantity of all raw materials necessary for producing one unit of product.
2. Coefficient of pollution P_m – quantity of pollutants produced during processing per one unit of product.
3. Coefficient of pollution utilization R_m – quantity of utilized pollutants per one unit of product.

As complementary indicators may be used complex parameters:

1) $\alpha_m = P_m/M$ – part of resources transformed into pollutants;
2) $\beta_m = R_m/M$ – part of utilized pollutants from total amount of resources ;
3) $\gamma_m = R_m/P_m$ – coefficient of utilization – part of utilized pollutants from total amount of pollutants.

Integral parameter ω_m comprise the main parameters mentioned above

$$\omega_m = (P_m - R_m)/M \qquad (4)$$

ω_m indicates the final part of used natural resources which is lost and form pollutants and waste products.

Industrial process in terms of material and energy flows to comprises the next parts:

First group includes basic resources A and additional resources a, used in the technological process, final industrial product B and resources b, necessary for exploiting the product.

Second group includes wastes produced in industrial sphere α; during exploiting the product β and the remnants of used product δ.

Third group includes additional resources e for utilization of wastes, additional products E created from wastes and final summarized nonutilized wastes α generated during manufacturing, exploiting and processing.

On the base of these parameters may be constructed two complex environmental reliability indicators -- the useful exploiting of resources indicator:
the effectiveness of waste products utilization indicator

$$R = \frac{B + E}{A + a + b + e} \qquad (5)$$

$$\omega = \frac{\varepsilon}{\alpha + \beta + \delta} \qquad (6)$$

Every industrial technology is based on exploiting of natural resources. It means that industrialization leads to decreasing of natural resources and their transformation in waste products. Due to this the quality of environment becomes more worse.
Environment quality conservation indicator V_k may be calculated by the next formula [6]:

$$V_k = (Q - 0{,}5\,Lt^2 \qquad (7)$$

where: Q – the maximum capacity of analyzed environment;
L – acceleration of environment quality losses;
t – time.

On the second hand industrialization is connected with growing of men's life quality.

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If there are not limits theoretically men's demands for comfort and rising life quality C_k can be described by exponential equation.

(8)

$$C_k = a_0 e^{Et}$$

where: a_0 – men's life quality minimal level;

E – intensivness of industrialization

But in these conditions the man will exhaust the limits of nature quality during the critical period t_{cr}, which can be obtained from equation (7), when $V_k=0$.

(9)

$$t_{cr} = \sqrt{\frac{Q}{L}}$$

The sustainable development demands to reduce impact of industrial technologies on nature and environment and in this case there must be more less growth of life quality as it is shown by next equation:

(10)

$$C_k = a_0 + QEt - Lt^2 + E^2$$

The equation declare that sustainable development ($t_{cr} \to \infty$) is possible only when $L \leq 0$, or when production of wastes must be reduced proportionally to growing of industries powerty (fig.1)

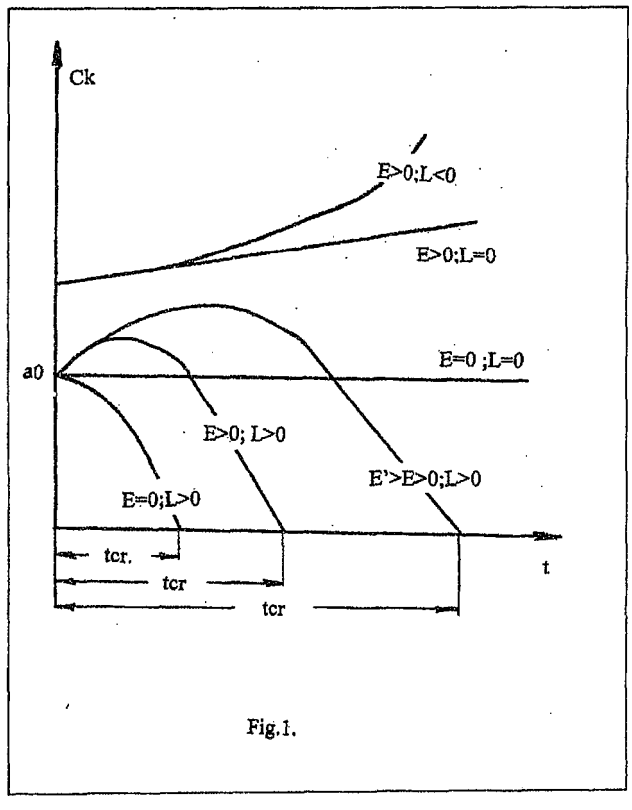

Fig.1.

(11)

$$E = 0{,}5\sqrt{Q^2 t^2 + 4Lt} - Qt$$

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But such conditions are possible only if the existing technologies will be changed in ecotechnologies.

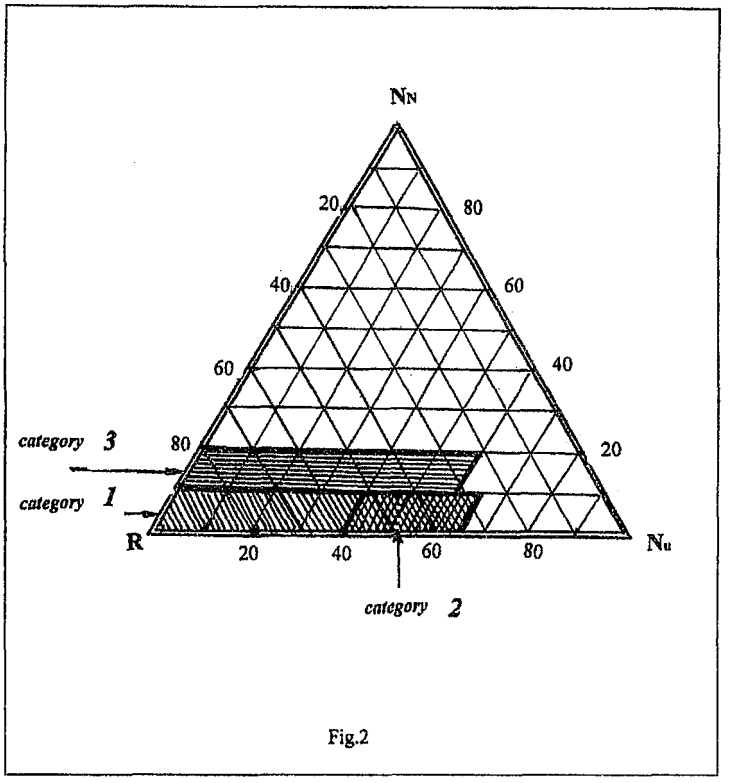

Fig.2

The level of environmentally sound technology may be evaluated on the base of structural triangle diagram (fig.2), where the main three parameters are used:

1) Non utilized final wastes coefficient (12)

$$N_N = \frac{\varepsilon}{A+a+b+e}100,\%$$

2) Useful part of resources coefficient (13)

$$R = \frac{B}{A+a+b+e}100,\%$$

3) Utilized part of wastes coefficient (14)

$$N_u = \frac{E}{A+a+b+e}100,\%$$

The technologies of highest I category has on the diagram square in the next limits $N_N \leq 10\%$, $R \geq 50\%$, $N_u \leq 40\%$.

The technologies of middle II category:

$N_N \leq 10\%$, $R = 25\%–50\%$, $N_u = 65\%–40\%$.

The lowest III category technologies:

$N_N \leq 10\%–20\%$, $R \geq 20\%$, $N_u \leq 50\%$.

The other technologies can not be considered as ecotechnologies.

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The analyze of theoretical equations proves, that progress and sustainable development can be achieved only by developing environmentally sound technologies on the basis of industrial ecology.

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DAŽĀDU AGROĶIMIKĀLIJU IETEKME UZ ZIEMAS KVIEŠU PIEAUGUMA INTENSITĀTI
IMPACT OF VARIOUS AGRO–CHEMICALS ON WINTER WHEAT GROWTH INTENSITY

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Abstract. *Also, each treatment of the field results in a certain stress for the plants. The natural physiological processes within a plant are hindered influencing the growth of a plant.*

The objectives of the paper were to determine influence of retardant, herbicide and nitrogen on growth dynamics and the development of vegetation stages in winter wheat. The field experiments were carried out during 1998 to 1999 in Research and Training Farm "Pēterlauki" on sod calcareous medium loam, pH $_{KCL}$ – 7.0, humus content 20 to 25 g kg^{-1} in soil. The research was carried out in the fields of intensive type of winter wheat 'Otto' with the following treatments: control; control + herbicide; control + retardant; $N_{60 + 70 + 40}$ + retardants.

Herbicide Dialen (2,0 l ha^{-1}) and retardant Cikocel (1,5 l ha^{-1}) was applied during the final stage of tillage, when testing parted nitrogen fertiliser, the first part (N_{60}) was used after vegetation period was resumed. The second part (N_{70}) was applied at the beginning of stalking stage (Zadoks Growth Stage 30). The third part (N_{40}) – during shooting into ears.

The growing dynamics was registered by aucsinographs (designed by I.Gronskis, M.Āboliņš). This equipment allows to observe and to register the intensity of plant growth length within twenty–four hours. Registration tapes were changed every twenty–four hours.
The analysis of the results showed that the most intensive plant growth happened in the morning (9:00 – 12:00 a.m.) and in the afternoon (3:00 – 6:00 p.m.). A decrease in the growing intensity was observed during night and midday. The data show how that the growth of winter wheat was seriously hindered even 2 weeks after the treatment with agro–chemicals. Winter wheat growing in length stops in the middle of flowering stage.

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