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ECONOMIC BASES OF INTERNATIONAL MECHANISMS ON CLIMATE CHANGE

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Neither the UN Framework Convention on Climate Change nor the Kyoto Protocol nor other international agreements aiming at the establishment of legal and economic – and also sustainable – world development mechanisms seeking to achieve a harmony between economic growth and preservation of the environment have led to any reduction in annual increases of anthropogenic greenhouse gas emissions.

This is due, to a considerable extent, to the initially non-complete principles of evaluation regarding the different responsibilities of countries in connection with atmosphere pollution. The aforementioned principles are based on total emissions volumes. However, what might be seen as more justified in any estimation of permissible pollution levels is, within potential international trading of volume quotas for the rights to carbon dioxide emissions, an account of the intensity of pollution per square kilometer of surface area and the absorption potential of forests and other green plantations present in every country.

Keywords: environment, environment protection, renewable resources and conservation, environmental management, climate, greenhouse effect, CO_2 emission, international trade rights to greenhouse pollution

JEL classification index: F18, Q25

1. INTRODUCTION

International agreements on climate change have established quantitative restrictions with regard to the total volume of anthropogenic carbon dioxide emissions in a country. However, such an approach does not reflect the real role played by any individual country in world pollution. In addition to existing methods, this article proposes a new way of calculating emissions levels and international quota trading volumes, where the area and the adsorption characteristics of a country's existing territory are taken into account.

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The article proceeds as follows: Section 2 outlines the institutional basis of the international climate change mechanisms; Section 3 shows the distribution of carbon dioxide emissions per country in the world; Section 4 presents the differentiation of responsibilities for world pollution; Section 5 reflects governing priorities of the international carbon dioxide emissions reduction programmes; finally, conclusions are contained in Section 6.

2. INSTITUTIONAL BASIS OF INTERNATIONAL MECHANISMS DEALING WITH CLIMATE CHANGE

The acceleration of the international economic growth in the second half of the 20th century and the processes of industrialization have led to a significant increase in coal, oil and natural gas consumption. Simultaneously, there has been an increase in the quantity of gas emissions stemming from the burning of fossil fuels and the manufacturing of cement. The increasing anthropogenic pressure on the environment has led to significant weakening of the planet's absorption capacities as a result of the permanent reduction of areas of forest – the basic absorbers of carbon dioxide – which has, over time, led to the commencement of a world temperature increase in consequence of the greenhouse effect.

Preservation of the environment was recognized as a world community priority at the UN Conference in Rio de Janeiro in 1992, which was attended by heads of states or governments from 179 countries. This Conference approved the UN Framework Convention on Climate Change (UNFCCC), which determined the important institutional principle of the "common, but differentiated responsibility" of all parties concerning the level of man-made greenhouse gases existent in the Earth's atmosphere. The Rio Conference's "Agenda 21" designated sustainable development as a world imperative serving to define the basic objectives of international co-operation in the achievement of harmonization between economic growth and protection of the environment (UNFCCC, 1992).

Specific quantitative commitments from 39 countries regarding greenhouse gas emissions reductions were determined in the Kyoto Protocol of 11 December 1997 (Annex B). The parties committed themselves to lowering their total greenhouse gas emissions by 5% compared to the levels of 1990 over the years 2008–2012. The Protocol takes on board both developed and transition countries and creates the economic basics toward increased global co-operation on climate change. Thanks to their flexibility, the Kyoto mechanisms allow countries to make moves on their national strategies of restrictions/lowering of greenhouse gas emissions with smaller levels of economic expenditure. Besides emissions being reduced within their own territories, industrial countries can meet their commit-

ments by trading obligations occurring with the developing countries that have committed themselves to Kyoto targets or, instead, by funding emissions reduction projects in these countries through a system of limited and voluntary co-operation. For ex-socialist countries that have agreed to take on board emissions targets, the Kyoto Protocol allows for commitment trading, while the Joint Implementation scheme enables developed countries to acquire emission trading permits in return for supporting emissions reduction projects in transition economies. The Clean Development Mechanism might also allow industrial countries to buy project-based emissions rights from developing countries (UNFCCC, 1997).

Up to 1997, the UNFCCC had come into force in 165 states. The Kyoto Protocol will come into force after its ratification by 55 or more states with a total, shared amount of 55% of total world emissions. However, in 2002 the number of states that ratified the Protocol had not yet reach 55. Whilst the USA refuses to ratify the Protocol, the countries of the European Union and Russia intend to ratify this extremely important document in 2002–2003 (UNFCCC, 2002).

3. THE DISTRIBUTION OF CARBON DIOXIDE EMISSIONS PER COUNTRY IN THE WORLD

It is obvious that international programmes dealing with greenhouse gas emissions restrictions/reductions will occur most effectively if the Kyoto Protocol is ratified by all states – that is, the most large of the polluting countries of the world *(Table 1)*.

In *Table 1*, the dynamics of anthropogenic carbon dioxide (CO_2) emissions, the relative indices of pollution and the average annual rate of emissions growth are shown from 1980 until 1997 (the most complete data published recently by the World Bank). In 1997, 27 countries with individual shares exceeding 0.5% of total world emissions produced almost 85% of total man-made CO_2 emissions – while the total share of the 180 other countries and economies constituted only 15%. The share of the leading five countries: USA, China, Russia, Japan and India had nearly 55% of world emissions. Thus, the success of international climate change programs dealing with CO_2 pollution reduction depends on the attitude of a limited number of states, these states being the biggest producers of greenhouse emissions.

As it appears in *Table 1*, almost 75% of all global CO_2 emissions arises within 41% of the planet's area – and is produced by only fifteen countries. Among these countries are all the great powers – permanent members of the UN Security Council, and all G7 member states along with two of the most populated countries in the world, namely China and India (IBRD, 2002, pp. 232–233). To a

Table 1

Dynamics of carbon dioxide anthropogenic emissions in 1980–1997

Countries	Surface area A_i, thousands of km^2	Emissions of carbon dioxide, E_i, million metric tons					
		1980		1990		1997	
		total	% of E_w	total	% of E_w	total	% of E_w
USA	9364	4575.4	33.5	4824.0	29.8	5467.1	22.9
China*	9566	1494.0	11.0	2428.9	15.0	3618.8	15.2
Russia	17075	...	...	1954.4	12.1	1444.5	6.1
Japan	378	920.4	6.7	1070.7	6.6	1204.2	5.0
India	3288	347.3	2.5	675.3	4.2	1065.4	4.5
Germany	357	...	...	889.2	5.5	851.5	3.6
UK	245	583.8	4.3	563.3	3.5	527.1	2.2
Canada	9971	420.9	3.1	409.6	2.5	496.6	2.1
South Korea	99	125.2	0.9	241.2	1.5	457.4	1.9
Italy	301	371.9	2.7	398.9	2.5	424.7	1.8
Mexico	1958	251.6	1.8	295.0	1.8	379.7	1.6
Ukraine	604	...	...	631.1	3.9	370.5	1.6
Poland	313	456.2	3.3	347.6	2.1	357.0	1.5
France	552	482.7	3.5	353.2	2.2	349.8	1.5
South Africa	1221	211.3	1.5	291.1	1.8	321.5	1.3
Australia	7741	202.8	1.5	266.0	1.6	319.6	1.3
Brazil	8547	183.4	1.3	202.6	1.3	307.2	1.3
Iran	1633	116.1	0.9	212.4	1.3	296.9	1.2
Saudi Arabia	2150	130.7	1.0	177.1	1.1	273.7	1.1
North Korea**	121	...	...	...	...	260.5	1.1
Spain	506	200.0	1.5	211.7	1.3	257.7	1.1
Indonesia	1905	94.6	0.7	165.2	1.0	251.5	1.1
Thailand	513	40.0	0.3	95.7	0.6	226.8	1.0
Turkey	780	76.3	0.6	143.8	0.9	216.0	0.9
Venezuela	912	89.6	0.7	113.6	0.7	191.2	0.8
Argentina	2780	107.5	0.8	109.7	0.7	140.6	0.6
Malaysia	330	28.0	0.2	55.3	0.3	137.2	0.6
27 countries together	83,231					20,214.7	84.7
The other 180 countries	50,341					3,653.5	15.3
The world ($_w$)	133,572	13,640.7	100	16,183.1	100	23,868.2	100

Table 1 (cont.)

	Intensity of emissions							
	Per capita Epc, tons/person			On the unit of surface area $I_i = E_i/A_i$, tons/km^2			E_i, Average annual growth rate (%)	
	1980	1990	1997	1980	1990	1997	1980–90	1990–97
USA	20.1	19.3	20.4	489	515	584	0.5	1.8
China*	1.5	2.1	2.9	156	254	378	5.0	5.9
Russia	...	13.1	9.8	...	114	85	...	–4.2
Japan	7.9	8.7	9.6	2435	2833	3186	1.5	1.7
India	0.5	0.8	1.1	106	205	324	6.9	6.7
Germany	...	11.1	10.4	...	2491	2385	...	–0.6
UK	10.4	9.8	8.9	2383	2299	2151	–0.4	–0.9
Canada	17.1	14.7	16.6	42	41	50	–0.3	2.8
South Korea	3.3	5.6	9.9	1265	2436	4620	6.8	9.6
Italy	6.6	7.0	7.5	1236	1325	1411	0.7	0.9
Mexico	1.5	3.5	4.0	128	151	194	1.6	3.7
Ukraine	...	12.1	7.4	...	1045	613	...	–7.3
Poland	12.8	9.1	9.2	1458	1111	1141	–2.7	0.4
France	9.0	6.2	6.0	874	640	634	–3.1	–0.1
South Africa	7.7	8.3	8.5	173	238	263	3.3	1.4
Australia	13.8	15.6	16.8	26	34	41	2.7	2.7
Brazil	1.5	1.4	1.9	22	24	36	1.0	6.1
Iran	3.0	3.9	4.9	71	130	182	6.2	4.9
Saudi Arabia	14.0	11.2	13.7	61	82	127	3.1	6.4
North Korea**	...	...	11.4	...	...	2153	...	0.7
Spain	5.3	5.5	6.6	395	418	510	0.6	2.8
Indonesia	0.6	0.9	1.3	50	87	132	5.7	6.2
Thailand	0.9	1.7	3.7	78	187	442	9.1	13.1
Turkey	1.7	2.6	3.4	98	184	277	6.5	6.0
Venezuela	5.9	5.8	8.3	98	125	210	2.4	7.7
Argentina	3.8	3.4	3.9	39	39	51	0.2	3.6
Malaysia	2.0	3.0	6.5	85	168	416	7.0	13.9
27 countries together						243		
The other 180 countries						73		
The world ($_w$)	3.4	3.3	4.1	102	170	179	1.7	5.7

Notes: * Including Hong Kong and Macao, excluding Taiwan.
** For 1995–1997.
Sources: Calculations by the author from IBRD (2001, pp. 290–293; 2002, pp. 232–233).

large extent, the economic and financial power, technological possibilities and political influence of these fifteen countries will eventually determine the advancing of climate-changing international programmes therefore the drawing of all of these countries into binding agreements on CO_2 emissions is vital for any programme implementation. Nonetheless, this does not underestimate the importance of prompting all other countries (no matter how small) into actively participating in environmental protecting.

Analysis of the data laid out in *Table 1* persuasively refers to the unsubstantiated arguments of many developing countries, which are based on the premise that the high concentration of CO_2 in the Earth's atmosphere is the result of the industrialization of the developed countries – and, consequently, only the rich countries ought to be blamed for such a problem.

Among the 27 countries, only nine countries belong to the high-income group, i.e. with a GNI per capita of $9266 or more. India, Indonesia, North Korea and Ukraine belong to the low-income group, with a GNI per capita of less than $756; while China, Iran, Russia and Thailand go into the lower middle-income group, i.e. with their having a GNI per capita of $756–2996 (The World Bank, 2002, pp. 250–251).

However, several of these nine developing and transition economies, with a total share amount nearing one third of world CO_2 emissions – due to exceptionally high, average annual pollution growth rates (from 5.9% in China up to 13.1% in Thailand) – could point the way to a transformation in the positioning of the main global polluters. Thus, China – the world leader in the production of cast iron, steel, cement and in the use of energy and caking coals – is likely to exceed the USA in the quantity of CO_2 emissions by 2008. This situation is worsened by the fact that in many developing countries tree-felling is proliferating (from 1.0% annually in Indonesia up to 2.6% in Thailand), contrasting with the majority of the developed countries, i.e. where a policy of annual increases in trees planted is actively applied (IBRD, 2001, pp. 290–291). However, no limits on emissions coming from developing countries (other than from the economies in transition) were set at the Kyoto Conference.

The second argument put forward by China, India and some other developing countries in declining to enter into any binding Kyoto Protocol commitments points to the fact that their current *per capita* CO_2 *emissions* are still much lower than in either industrial or transition economies. Undoubtedly, such industrial country emissions are considerably higher compared to those coming out of developing countries. As we can see in *Table 1*, the per capita CO_2 emissions of the USA, Australia or Canada exceed by 12–15 times the analogous indices for India or Indonesia. The use of this additional unit of measurement allows us, in addition,

to avoid "false" evidence pointing to an actually non-existent amount of pollution reduction in countries where the average annual population growth rate exceeds the CO_2 emissions growth rate. So, for example, per capita emissions in Saudi Arabia have been going *down* since 1980, even though the volume in total has gone *up* by more than twice.

Yet using only a per capita index as a unit of measurement of CO_2 emissions levels distorts the real extent of country contributions to world pollution as a whole. If we introduce a new unit of measurement: the intensity of emissions $I = E/A$, defined by division of the total emissions quantity E by the country's surface area A, it will become obvious that, in 1997, the level of CO_2 pollution in India (324 t/km^2) could be compared with the USA's level (584 t/km^2) with such measurements, for example, exceeding analogous indices pertaining to Canada (50 t/km^2) and Australia (41 t/km^2) by more than 6–8 times.

The intensity of emissions per area unit also lets us estimate the excess level of emissions in each country as related to the world's average.

4. THE DIFFERENTIATION OF RESPONSIBILITIES FOR THE WORLD POLLUTION

In the list of the world's biggest producers of CO_2, Russia, Canada, Australia, Brazil and other countries, in which the intensity of emissions is smaller than the average world index level, are distinctive. These countries not only neutralize their carbon dioxide emissions thanks to their being absorbed into their own forests – they can also be considered purifiers of the "foreign" emissions that enter their area due to atmosphere movement.

A definition of the level of differentiated responsibility for world emissions with regard to countries can be arrived at after seeing the quantity of excess emissions Q_E, which is calculated via taking into consideration the absorbent faculty of the country in question:

$$Q_E = (I_i - I_w) \times A_i - a_f \times A_F, \quad (1)$$

where

I_i = the real intensity of CO_2 emissions in the i-country, in tons/km^2;
I_w = basic world permissible level of emissions, in tons/km^2;
A_i = the i-country area, in km^2;
a_f = the absorption capacities of forests and other green areas (quantity of CO_2 absorbed in the photosynthesis process within one year), in tons/km^2;
A_F = the total area of forests, woods, parks and other tree/shrubbery areas in the country, in km^2.

A negative value had by Q_E points to a relative normal ecological situation in a given country – while a positive value testifies the need to make appropriate payments to other countries, that is, to the ones that neutralize these surplus CO_2 emissions on their territories. For example, in our rough estimate (calculations based on $I_w = 102$ t/km^2 as safe average world level of intensity; $a_f = 1500$ t/km^2; absorption in forests and woodland only, without seasonal crops (Koucheryavy, 2000, p. 343)), the greatest amount of excess CO_2 emissions in 1997 were produced in China, Japan, Germany, the USA and the UK (with surpluses of about 950, 700, 650, 525 and 450 million tons respectively). Among NAFTA countries, Canada and Mexico absorbed into their forests about 5,300/500 million tons of "foreign" CO_2 emissions, while in the USA a surplus of around 525 million tons was produced. In the European Union only two countries – namely, Finland ($Q_E = -325$ million tons) and Sweden ($Q_E = -390$ million tons) – did not have excessive emissions. In addition to the Yandle arguments, the aforementioned data "helps explain why some energy firms, trade associations and countries jumped eagerly onto the Kyoto bandwagon – and why others view the Accord as a 'protectionist', cartelisation device" (Yandle, 1999).

The total cost S of the trade emissions quota (or the payments for excess pollution) can be calculated by using the following formula:

$$S = Q_C \times Q_E \times P_1, \tag{2}$$

where

Q_C = 12/44 – coefficient, converting CO_2 gas emission volumes into hard carbons ones;
Q_E = quantity of excess emission
P_1 = cost of a unit of carbon emissions reduction.

In some projects carried out by UNEP in the 1990s, the value of P_1 goes from $8.30 per ton of carbon in the sustainable energy management project in Burkina Faso to $10 in Costa Rica, where the Clean Development Mechanism has already begun to act by trading in Certified Tradable Offsets (IBRD, 2000, pp. 102, 104). For the most precise calculations, though, the cost curves of greenhouse gas mitigation will come in useful (Szlávik et al., 1999).

Implementation of the national and international programmes dealing with Earth atmosphere purification has an effect on the production of public goods: clear air and a more safe environment, i.e. which are non-excludable and non-rivalry-creating across state borders. All countries will benefit from the fulfilment of greenhouse gas reduction programmes, regardless of whether a country has made any contribution in these programmes or refused to participate in them. Consequently, involving of *all* the world's countries in participation in such

programmes also needs additional regulations – like the imposition of trade and other sanctions against countries where an increase in atmosphere pollution constitutes a threat to the world community's health.

The basic level of CO_2 emissions – via which the reduction quota calculation for the Kyoto Protocol Parties is carried out – also requires essential correction. The total levels of emissions in 1990, determined on the basis of this Protocol, are well *under*estimated. After the prescribed reductions, according to the Protocol, the achievable level of emissions will exceed the 1980 level by 12–15%. *Inter alia*, only the world emissions level of 1980 may be seen as being relatively safe because "the 20th century has been the warmest century in the past 600 years, and 14 of the warmest years since the 1860s occurred *in the 1980s and 1990s* (the italics are mine). Temperatures in 1998 were higher than the mean temperatures for the 118 years on record" (IBRD, 2000, p. 41). The unexpected droughts or floods in many countries in Europe, Asia and America during the last four years confirm the intensifying of these worrying trends.

For centuries, the greenery of the earth and ocean absorbed $(1.7\ldots2.0)10^{11}$ tons of CO_2 annually (Koucheryavy, 2000, p. 442). Over the three last decades, the intense deforestation and the destruction of mangroves and coral reefs has substantially decreased the planet's absorption potential. "Just one-fifth of the earth's original forests remains in large, relatively natural ecosystems… Seventy-six countries have lost all of their frontier forest, and 70 percent of what is left is found in just three countries: Brasilia, Canada and Russia" (IBRD, 2000, pp. 42–43). As a result "the green lungs of the planet" occupy only 30% of the land area. Now, the anthropogenic pressure on the natural ecosystems exceeds their restoring ability by more than 30% (Wackernagel and Rees, 1997).

The aforementioned data shows that, after 1980, the natural mechanisms of climate self-adjustment were being seriously harmed by the progressive accumulation of surplus quantities of CO_2 in the Earth's atmosphere. Consequently, the average world level of emissions intensity in 1980 (I_w = 102 tons of CO_2 per km^2) is likely to be acceptable as a basic criterion for calculation of both permissible levels of emissions and of trade quotas. The validity of such an assumption is also indirectly confirmed by the Kyoto Protocol, according to which the main polluting countries of the G7 – the USA and Japan – from 2008 to 2012 must lower their emissions by 7% and 6% respectively compared to their 1990 levels, i.e. the indices of 1980 need to be achieved.

OECD countries themselves emit about 3 billion tons of carbon dioxide a year. The Kyoto Protocol alone will reduce the emissions these countries would have produced without this agreement by at least 30% – and if only half of the reductions are met through quota trading, the global quota market will be worth $11.5

billion a year (IBRD, 2000, p. 101). Thus, implementation of the international programmes for anthropogenic CO_2 emissions reduction through quota trading is exceptionally important for industrial and developing countries and also the transition economies.

The so-called "green" taxes levied on carbon dioxide emissions or on the burning of fossil fuels has led to a reduction of the energy-expense production of goods and services in Austria, Germany, Greece, Italy and other European Union countries; and even though the intensity of CO_2 emissions in the EU in 1997 exceeded by 5.3 times the world's average (954 and 179 t/km^2 relatively), the annual growth rates of commercial energy usage in fifteen countries of the EU differed from the average world growth rates by 30% (at 1.0% and 1.3% respectively) – and the average growth rates of carbon dioxide emissions was 15 times smaller than in the rest of the world (*Table 2*).

5. GOVERNMENTAL PRIORITIES OF THE INTERNATIONAL CARBON DIOXIDE EMISSIONS REDUCTION PROGRAMMES

Further tax increase for fossil fuels and the eliminating of subsidies for the most energy-using sectors (coal and ore mines, metallurgy, the cement industry etc.) could substantially reduce CO_2 emissions. However, such measures will inevitably be related to dangers of deceleration of a country's economic development, an exacerbation of social divisions and other undesirable economic and political consequences. Economic growth requirements for the next three decades will lead to an increase in world energy consumption by 3–3.5 times. The demand for electric power in developing countries is projected to climb by as much as 300% between 1990 and 2010, outpacing by far the 20% rise expected in industrial countries (IBRD, 2000, p. 101).

Several authoritative economists suggest that the world's poorest countries and people's – those likely to be hit hardest by global warming – would benefit more from the industrial countries honouring pledges on aid and from opening up their markets than they would from pursuing aggressive greenhouse gas emission reductions (Lomborg, 2000). However, it is obvious that developed countries will *not* offer their expensive energy-efficient innovation technologies or up-to-date equipment free of charge to those in need – i.e. low-income countries will thus be forced to buy them. Undoubtedly, however, such purchasing requirements will be impractical in the foreseeable future as poverty eradication will remain the overriding priority in the majority of developing countries for a long time.

Table 2

Energy use, carbon dioxide emissions and deforestation in the countries of the EU and BSEC, 1990–1997

Countries	Commercial energy use			CO_2 emissions per unit of territorial area				
	Thousand metric tons of oil equivalent		Average annual growth, %	Total intensity, tons/km^2		Average annual growth, %	Annual deforestation 1990–1995	
	1990	1997	1990–1997	1990	1997	1990–1997	km^2	Average annual change, %
Austria	25,699	27,661	1.1	683	747	1.3	0	0.0
Belgium	48,426	57,125	2.4	2952	3491	2.4	0	0.0
Denmark	18,282	21,107	2.1	1179	1340	1.8	0	0.0
Finland	28,813	33,075	2.0	151	167	1.4	166	0.1
France	227,600	247,534	1.2	640	634	–0.1	–1608	–1.1
Germany	355,732	347,272	–0.3	2491	2385	–0.6	0	0.0
Greece	22,056	25,556	2.1	547	661	2.7	–1408	–2.3
Ireland	10,463	12,491	2.6	426	531	3.2	–140	–2.7
Italy	153,316	163.315	0.9	1325	1411	0-9	–58	–0.1
Luxembourg	2092	2480	2.5	2950	3186	1.1	0	0.0
The Netherlands	66,593	74,910	1.7	3388	3938	2.2	0	0.0
Portugal	16,419	20,400	3.2	460	585	3.5	240	0.9
Spain	90,552	107.328	2-5	418	510	2.8	0	0.0
Sweden	47,747	51,934	1.2	108	108	0.0	–24	0.0
UK	213,090	227,977	1.0	2299	2151	–0.9	–128	–0.5
EU–15	1,326,880	1,420,265	1.0	928	948	0.4	–3392	–1.3
Albania	2567	1048	–12.0	290	59		0	0.0
Armenia	7941	1804	–19.1	123	97		–84	–2.7
Azerbaijan	22,841	11,987	–8.8	541	370		0	0.0
Bulgaria	27,126	20,616	–3.8	678	454		6	0.0
Georgia	10,590	2.295	–19.6	217	65		0	0-0
Moldavia	9,959	4,436	–10.9	641	309		0	0.0
Romania	61,117	44,135	–4.5	652	477		12	0.0
Russia	906,433	591,982	–5.9	114	85		0	0.0
Turkey	52,498	71,273	4.5	186	277		0	0.0
Ukraine	252,631	150,059	–7.1	1045	613		–54	–0.1
BSEC–10	1,353,703	899,635	–5.7	160	118	–4.3	–132	0.0
The world	8,608,414	9,431,190	1.3	121	179	5.7	101,724	0.3

Notes: Negative numbers indicate an increase in forest area due to afforestation.
Sources: Calculated by the author from IBRD (2001, pp. 290–293; 2002, pp. 232–233).

Given a choice of most optimal strategies pointing towards CO_2 emission reductions and also energy saving projects, the afforestation programmes would be preferred because these have the biggest amount of social support. Forests are the best and most permanent CO_2 absorbers, are regulators of rain streams, provide anti-erosion and anti-landslide protection, and are also a renewable source of foodstuffs, a valuable recreation resource and, finally, a natural environment for many wild animals. The planting of new forests in wood-cutting locations as well as in former industrial areas (such as processed mines, quarries and other places that are unsuitable as agricultural areas) will not harm the economic interests of any social group or sector of industry in any country – and it will create new jobs, too. Hence, for many low-income countries afforestation is almost the only economically accessible method via which to neutralize their continuously increasing volumes of carbon dioxide emissions.

Since the end of the 1990s, the annual excess of CO_2 anthropogenic emissions in the world compared with the relatively safe level of 1980 went up to $(10…12)10^9$ tons of CO_2/km^2 or $(2.7…3.3)10^9$ tons C (in a carbon equivalent). A square kilometer of an evergreen rain forest in the tropics absorbs up to 5225 tons of CO_2 annually. For the mixed forests in mild climate areas this figure becomes (1500… 2200) tons of CO_2 (Koucheryavy, 2000, p. 343). For the absorption of about 3 billion tons of C emitted annually in the OECD countries since the mid-90s, the 600,000 km^2 of forests that will be planted in Brazil, Guinea and other tropical countries will be enough – or if given the (1.5…2) million km^2 of mixed forests planted in Greece, France, Italy, Ukraine and other countries with mild climates. Neutralization of (22…25) billion tons CO_2 that is emitted annually throughout the world requires a restoring of the cut down forests in an area of 10–12 million km^2 in all climate zones of the Earth. This work should begin without postponement because it has gigantic dimensions. The absorption effects of forests planted at the beginning of the 21st century will reveal itself fully only with the achievement of maturity by the trees, i.e. after 35–40 years.

The European Commission, adopting a new environmental strategy, has proposed an action plan for the period of 2001–2010 entitled *Environment 2010: Our Future, Our Choice* which focuses on four main areas of action: climate change, health and the environment, nature and biodiversity, as well as management of natural resources (EU, 2001). The Commissioner of the EU, Wallstrom says "Scientists claim that we should face up to the issue of climate change, otherwise we should accept the dramatic consequences. As is widely held, realisation of the Kyoto Protocol is not easy – however, it is the initial step. The Kyoto Protocol constitutes the most proper solution for timely pollution confrontation world-wide" (EU, 2000, p. 12). The main objective of this plan is accomplish-

ment of Community greenhouse gas emissions reduction by 8% between 2008 and 2012. It presupposes necessary structural changes in transport and energy sectors, in energy efficiency and energy saving, and in the establishment of a Community system of emissions trading. In addition, the European Commission stresses a necessary curtailment of world exhaust emissions by 20–40% by 2020 and, in the long run, the reduction of world emissions of greenhouse gases by 70% compared to the 1990 levels.

The most ecologically unsound countries of the EU – namely Belgium, Germany, Luxembourg, the Netherlands and the United Kingdom have not been able to substantially increase the absorption capacities of their green areas due to the high density of population and the lack of waste lands to major extents. These countries can ensure partial realization of their obligations by financing large afforestation projects in countries of the Organization of the Black Sea Economic Co-operation (BSEC) – Bulgaria, Romania, Russia or Ukraine – where new tree planting is completely non-significant despite the existence of large areas of land without crops. For example, in the Ukraine forests account for only 15.6% of its territory compared with 27.8% in France, which has approximately the same size of territory and is not much more densely populated. However, in France the forests are planted annually in thousands – while in the Ukraine only in tens – of square kilometers *(Table 2)*.

Only in BSEC countries, the area of waste lands (regions of former coal excavations, like Ptolemaida in Greece and the Donetsk coal field in Ukraine; non-arable lands in the European part of Russia etc.) amounts to a hundred thousand square kilometers. The planting of new forests in the countries of BSEC, from 2012 onwards, could become an important outward source of financing income, that is, as a payment for the absorption of emissions (according to Article 4.2.a of the UN Framework Convention).

6. CONCLUSIONS

Environmental problems can only be solved on a global scale – and sustainable development pointing towards ecological “reason” based on a new economic approach is necessary for the world.

In addition to existing methods, a new way of calculation, the intensity of emissions proposed in this paper, will allow us to specify more exactly which surplus carbon dioxide emissions need to be established. As a result, ecologically sound countries – whether industrial or developing or transition – could receive payments for carbon dioxide emission reductions and absorption. The rapid changes occurring in developing countries require a corresponding ability

to solve their ecological problems, and carbon quota trading could be used to transfer resources from industrial to developing countries under the Kyoto agreement – i.e. as "Debt-for-Nature swaps", these happening alongside other mechanisms – thereby strengthening international co-operation for a more effective realization of programs dedicated to greenhouse gas emission restrictions and reduction.

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