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ESTIMATING CARBON FLUX FROM THE SOIL USING LIFE-CYCLE MODEL OF TERRESTRIAL CARBON EXCHANGE

ENVIROMIS-2010

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The aim of our research is to develop a method which permit to evaluate annual carbon flux from soil for a given territory.

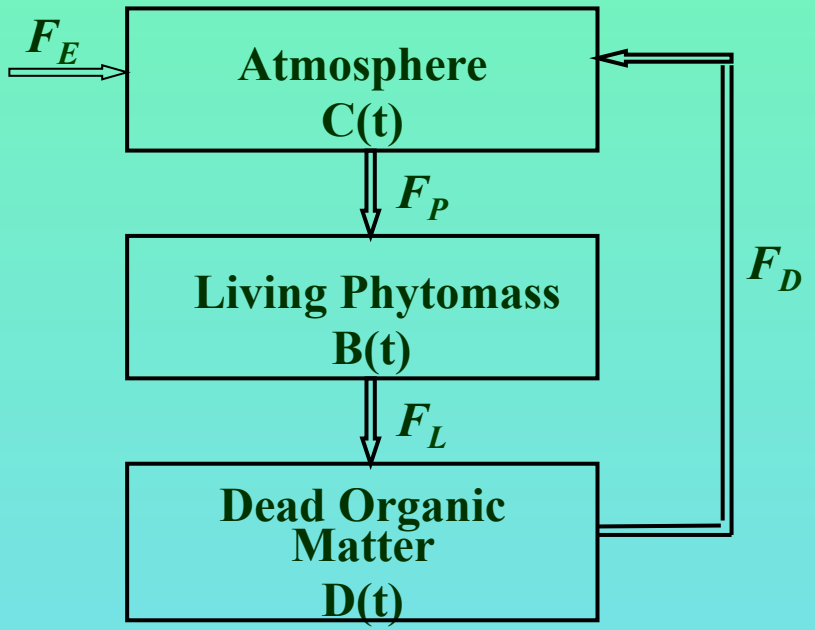
WHAT IS A SOIL RESPIRATION ?

CO_2 emission from soil surface is an amount of CO_2 produced by living roots, soil fauna, and soil microorganisms.

Contribution to the soil respiration (*Kudeyarov et al., 2006*):

living roots	– 33%
soil microorganisms (emission from dead phytomass – mortmass)	– 54%
soil microorganisms (emission from organic matter in soil – humus)	– 13%

BASIC STRUCTURE OF TERRESTRIAL CARBON CYCLE MODEL



$$\frac{dB}{dt} = F_P - F_L$$

$$\frac{dD}{dt} = F_L - F_D$$

$$\frac{dC}{dt} = -F_P + F_D + F_E$$

Flows:

F_P – production of organic matter

F_L – litter fall

F_D – decomposition of dead organic matter

F_E – anthropogenic emission of carbon

LIFE–CYCLE MODEL OF TERRESTRIAL CARBON EXCHANGE

$B(t,\tau)$ – **phytomass for "age" τ at time instant t**

(in carbon units)

$B_1(t,\tau)$ – **photosynthetic (green) phytomass**

$B_2(t,\tau)$ – **perennial phytomass (stems, branches, etc.)**

$B_3(t,\tau)$ – **root (underground) phytomass**

LIFE–CYCLE MODEL OF TERRESTRIAL CARBON EXCHANGE

$B(t,\tau)$ – **phytomass for "age" τ at time instant t**

living phytomass

L(t)

dead phytomass (mortmass)

M(t)

organic matter in soil (humus)

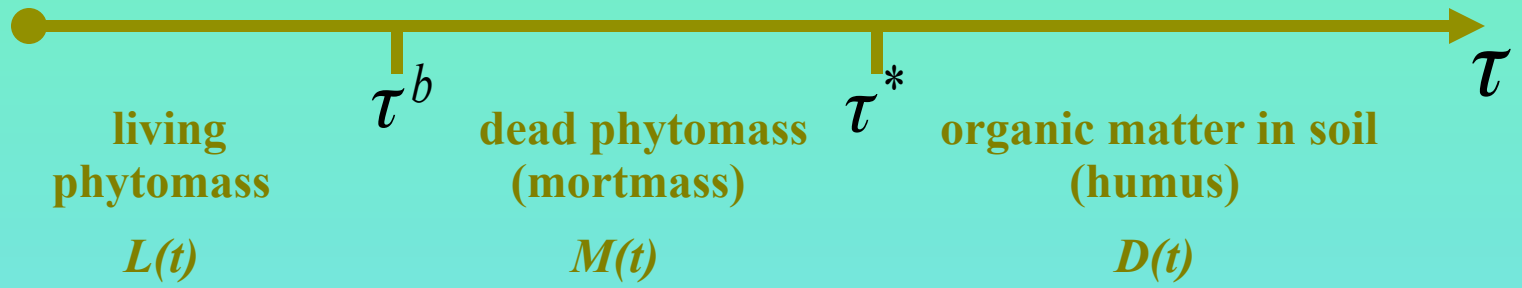
D(t)

LIFE–CYCLE MODEL OF TERRESTRIAL CARBON EXCHANGE

$B(t,\tau)$ – **phytomass for "age" τ at time moment t in carbon units :**

$B_1(t,\tau)$ – **photosynthetic phytomass** $B_2(t,\tau)$ – **perennial phytomass**

$B_3(t,\tau)$ – **root phytomass**



$$L(t) = \sum_{i=1}^{3} \int_{0}^{\tau_i^b} B_i(t,\tau)\,d\tau \qquad M(t) = \sum_{i=1}^{3} \int_{\tau_i^b}^{\tau_i^*} B_i(t,\tau)\,d\tau$$

$$D(t) = \sum_{i=1}^{3} \int_{\tau_i^*}^{\infty} B_i(t,\tau)\,d\tau$$

LIFE–CYCLE MODEL OF TERRESTRIAL CARBON EXCHANGE

Conservation law : $$\frac{\partial B_i}{\partial t} + \frac{\partial B_i}{\partial \tau} = -d_i(\tau)B_i - q(\tau)B_i$$

Decay coefficient :

$$d_i(\tau) = \begin{cases} 0, & if\ \tau < \tau_i^b \\ \mu_i, & if\ \tau_i^b \le \tau < \tau_i^* \\ \eta, & if\ \tau \ge \tau_i^* \end{cases}$$

Abiotic loss coefficient :

$$q(\tau) = \begin{cases} 0, & if\ \tau < \tau_i^b \\ q, & if\ \tau \ge \tau_i^b \end{cases}$$

Boundary conditions :

$$B_i(t,0) = p_i P(t)$$

$P(t)$ - **NPP**

p_i - **part of *i* komponent**

Function for NPP :

$$P(t) = \begin{cases} P_0, & if\ t < t_0 \\ P_0 e^{\lambda(t-t_0)}, & if\ t \ge t_0 \end{cases}$$

λ - **parameter determining atmospheric carbon impact on plant**

t_0 - **beginning of the industrial era**

CARBON FLUX FROM DEAD ORGANIC MATTER

Carbon emission from dead phytomass (mortmass):

$$W_1(t) = \sum_{i=1}^{3} \mu_i p_i \int_{\tau_i^b}^{\tau_i^*} P(t-\tau) e^{-\mu_i^{'}(\tau-\tau_i^b)} d\tau$$

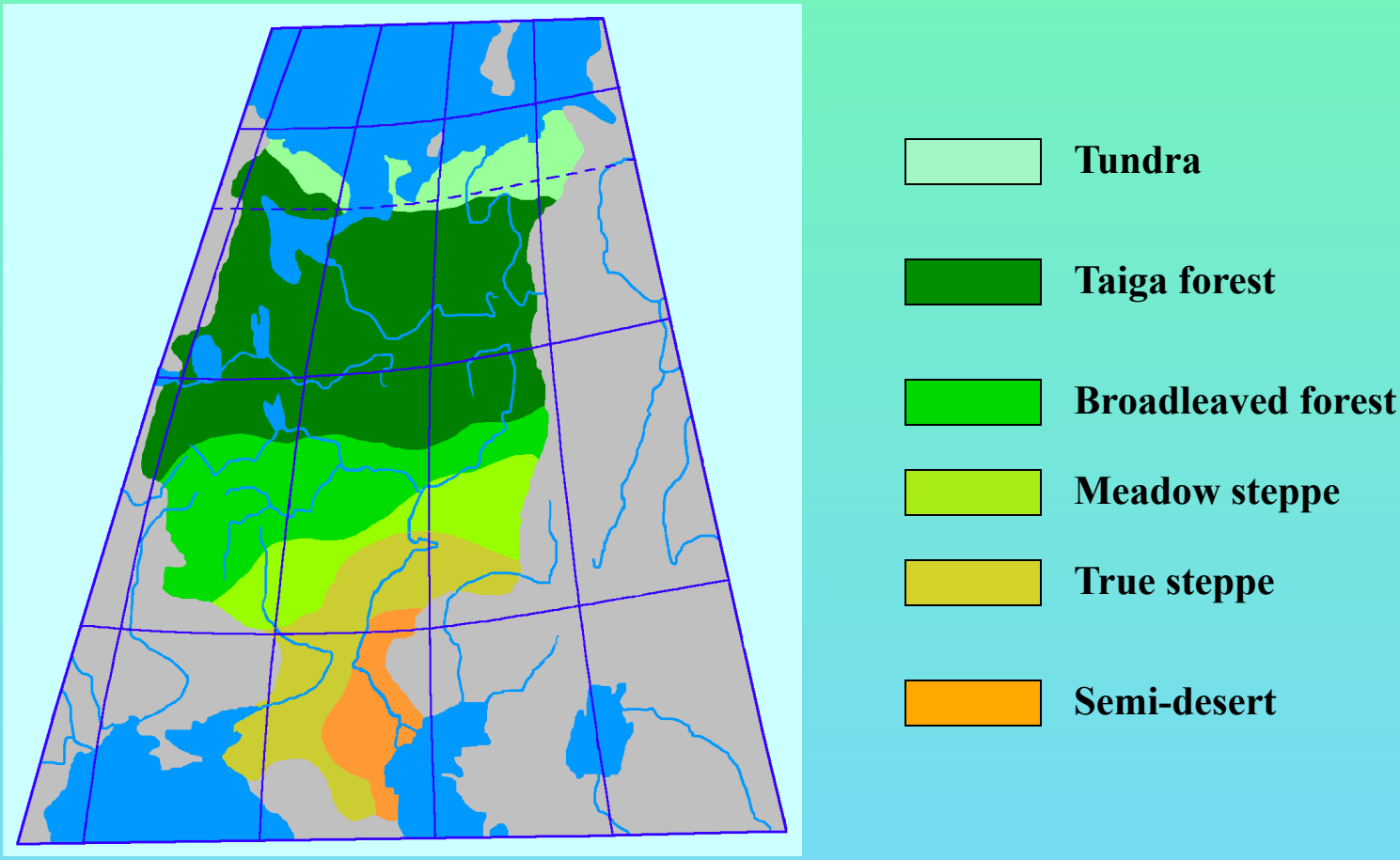
Carbon emission from organic matter in soil (humus):

$$W_2(t) = \eta \sum_{i=1}^{3} p_i e^{-\mu_i^{'}(\tau_i^*-\tau_i^b)} \int_{\tau_i^*}^{\infty} P(t-\tau) e^{-\eta^{'}(\tau-\tau_i^*)} d\tau$$

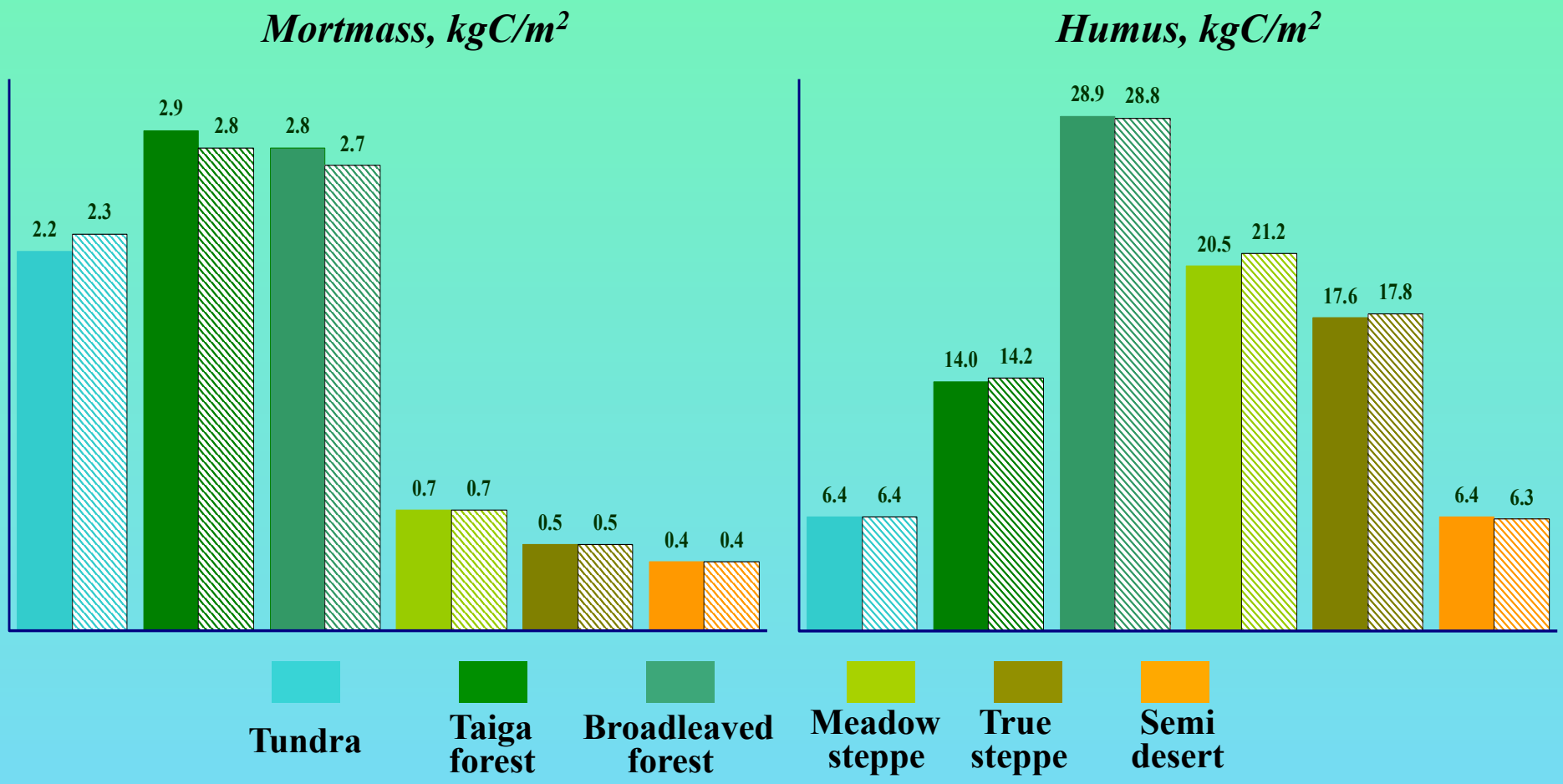
$$\mu_i^{'} = \mu_i + q$$

$$\eta^{'} = \eta + q$$

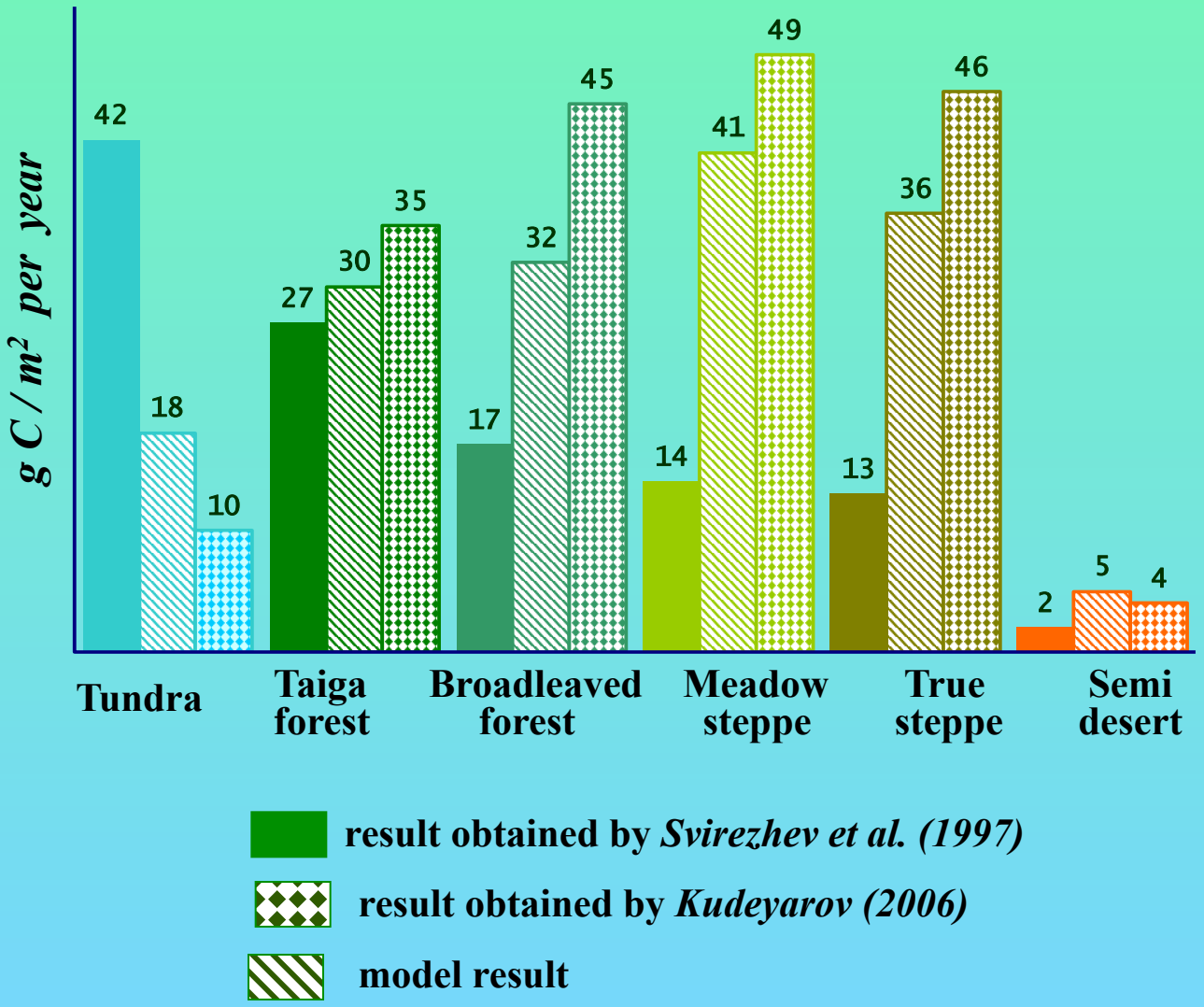
Ecosystems of the European Territory of Russia



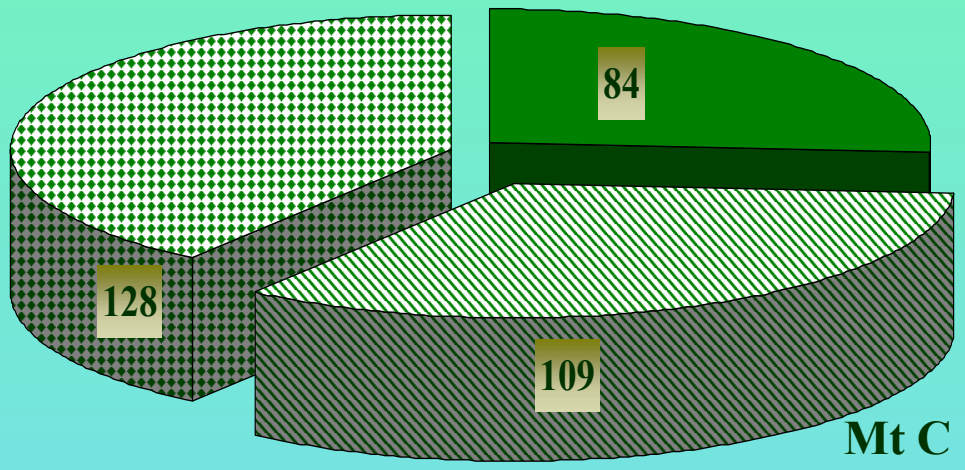
Verification of the Model for ETR Ecosystems



Estimations of Carbon Emission from Humus for ETR Ecosystems



Estimations of Carbon Emission from Humus for ETR Ecosystems

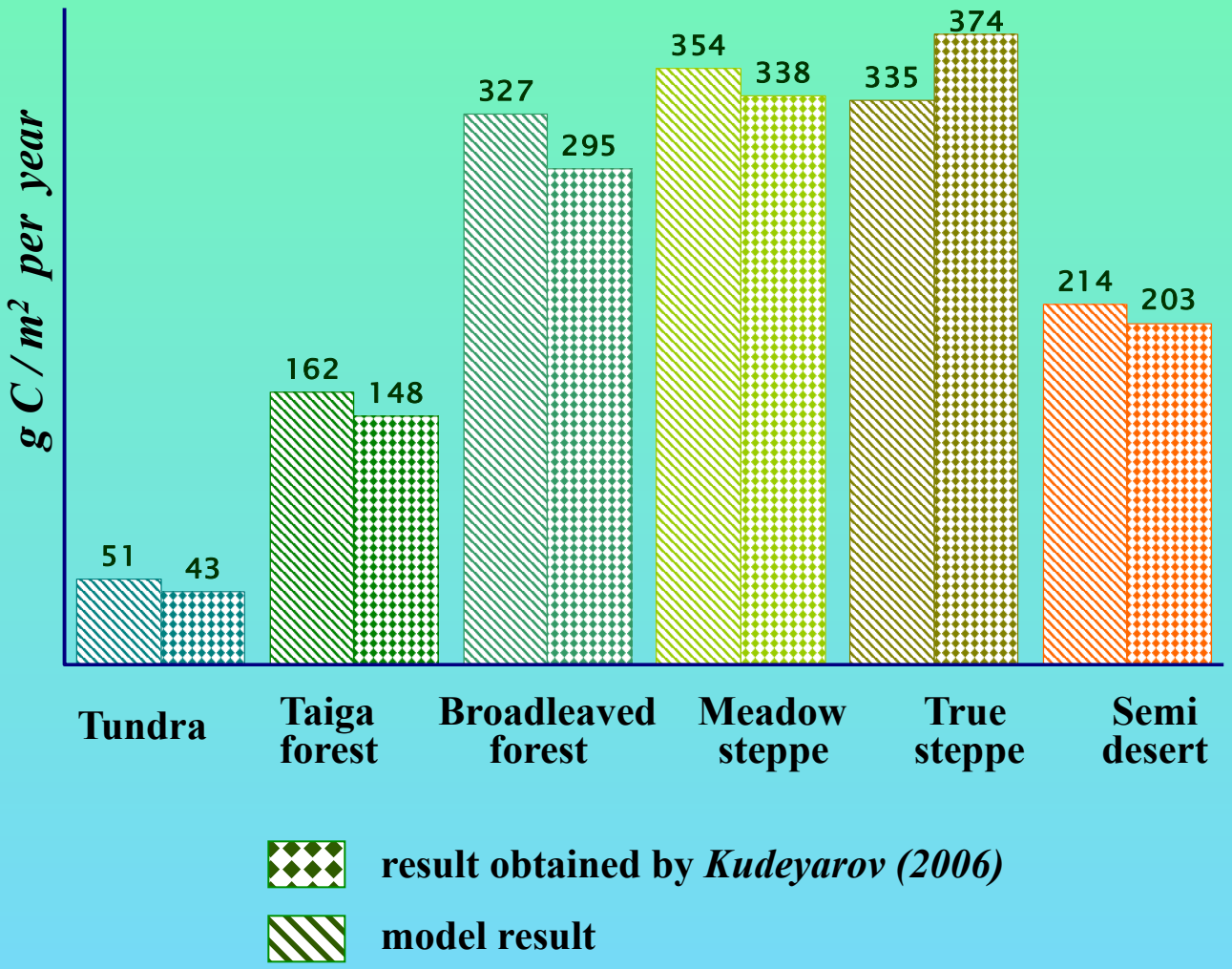


result obtained by *Svirezhev et al. (1997)*

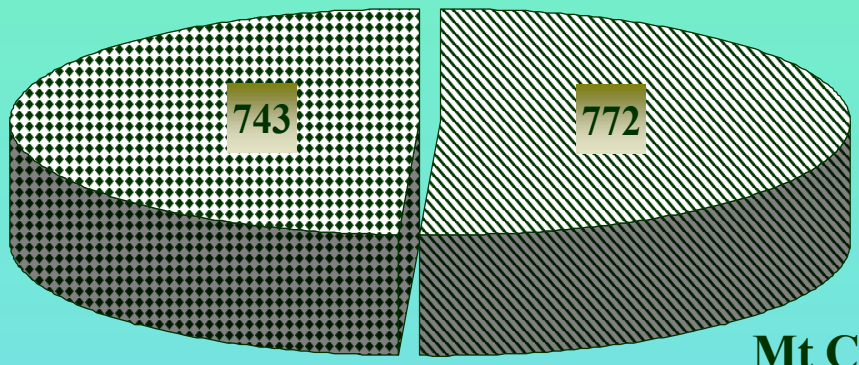
result obtained by *Kudeyarov (2006)*

model result

Estimations of Carbon Emission from Mortmass for ETR Ecosystems



Estimations of Carbon Emission from Mortmass for ETR Ecosystems

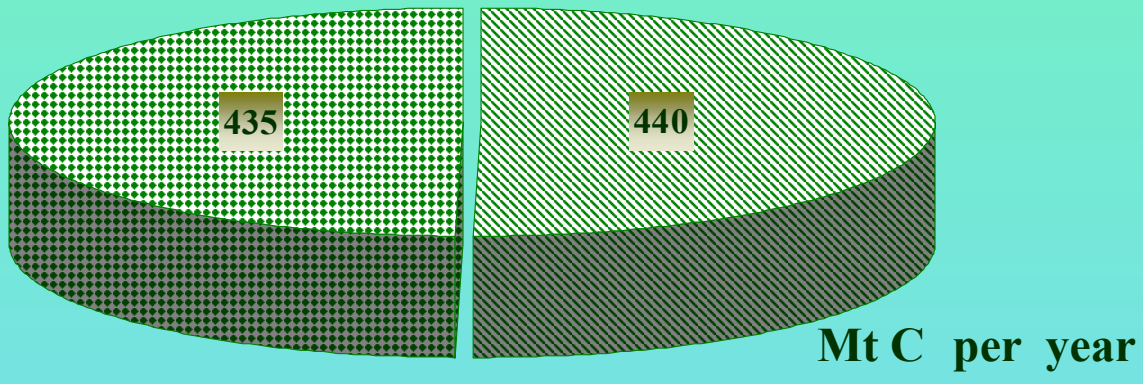


Mt C per year

result obtained by *Kudeyarov (2006)*

model result

Estimations of Carbon Emission from Living Roots for ETR Ecosystems



result obtained by *Kudeyarov (2006)*

model result

CONCLUSIONS

The suggested model permits us to evaluate the soil respiration of the territory under study.

The annual carbon flux from soil for European territory of Russia is evaluated as 1.3 Gt C.


THANK YOU FOR YOUR ATTENTION