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Malyarenko O., Samoilenko V.

Regional ecological networks: developed geoinformation modeling approaches

Malyarenko Oleksandr, Postgraduate
Samoilenko Viktor, Doctor of Science in Geography, Professor
Taras Shevchenko Kyiv National University, Kyiv, Ukraine

Abstract. The conceptual bases for geoinformation modeling of regional ecological networks were developed with substantiation of new algorithm by which such networks are consistently modeled from a set of (quasi)geosystems of actual natural-anthropogenic and/or (quasi)natural bio-landscape territorial structure with new artificial environmental elements addition. The modeling result has to be network ecological cores and corridors with their buffer zones, which are divided into prior and perspective for creation and must support an optimally formed frame of region's bio-landscape diversity.

Keywords: *bio-landscape territorial structure, (quasi)geosystem, regional ecological network, ecological core and corridor, geoinformation modeling*

Introduction. Substantiation of ecological networks creation at regional level is now the actual problem of natural geography because such networks essentially expand national and international ecological network structures and are used as "guide" for implementation of local ecological networks supporting principles of sustainable environment development.

Review of publications. In [3-5], considering existing experience summarized in [1-2]), there were proposed theoretic-applied bases for geoinformation modeling of regional ecological networks, particularly for mean by area river basins with close to ordinary degree of their economic infrastructure. So, ***the principal goal of this research*** is to improve methods of regional ecological network modeling towards increasing of their applicability in diverse economic-environmental conditions, including complicated.

Methods. The following **conceptual bases for regional ecological network geoinformation modeling** were formulated. Initially, ecological network modeling region (*ENMR*) should be considered as a combination of (quasi)natural (*QNS*), natural-anthropogenic (*NAS*) and anthropogenic (*AS*) structures. From here, in accordance with ([3-5]), dynamic of *ENMR* and its structures can be represented as

$$\mathrm{D}\{ENMR\} = \{QNS(\omega_{QNS},R_{QNS},t) \cap \\ \cap (NAS(\omega_{NAS},R_{NAS},t) \cup AS(R_{AS},t))\} \quad (1)$$

where $QNS(\omega_{QNS}, R_{QNS}, t)$ and $NAS(\omega_{NAS}, R_{NAS}, t)$ is a totality of *QNS* and *NAS* random fields; $AS(R_{AS}, t)$ – a totality of *AS* determined fields (see [3]); ω in general – a totality of elementary experimental results, i.e. ω_{QNS} and ω_{NAS} – number of mentioned random fields' registering (by fields' values and/or coordinates); R altogether – total spatial area of all fields in model (1), i.e. total boundaries of researched region under $R \in (x,y)$ in Cartesian coordinates of chosen for modeling GIS tools, wherefrom $R \in \{R_{QNS} \cap (R_{NAS} \cup R_{AS})\}$; t – continuous time parameter.

ENMR (quasi)natural structure (QNS) is divided into **singular substructures (*SNS*)** (second order subsystems) – *plane substructures* (*SNSP*) and *network biocentric substructure* ($SNSN_{QN}$), and also into **integrated network bio-landscape substructure** (***ISN_{QN}***) in accordance with notation

$$\mathrm{D}\{QNS\} = \{QNS(\omega_{QNS},R_{QNS},t)\} = \\ = \{SNS(\omega_{SNS},R_{SNS},t) \cap ISN_{QN}(\omega_{ISN_{QN}},R_{ISN_{QN}},t)\} = \\ = \{(SNSP(\omega_{SNSP},R_{SNSP},t) \cap SNSN_{QN}(\omega_{SNSN_{QN}},R_{SNSN_{QN}},t)) \cap \\ \cap ISN_{QN}(\omega_{ISN_{QN}},R_{ISN_{QN}},t)\} \quad (2)$$

where $\boldsymbol{\omega_{SNS}}$, $\boldsymbol{\omega_{SNSP}}$, $\boldsymbol{\omega_{SNSN_{QN}}}$ and $\boldsymbol{\omega_{ISN_{QN}}}$ – registering number for random subfields of appropriate substructures in (2); R_{SNSS}, R_{SPS}, $R_{SBNS_{QN}}$ and $R_{ISN_{QN}}$ – spatial subfields' subareas of these substructures provided that $R_{QNS} \equiv R \in \{(R_{SNSP} \cap R_{SNSN_{QN}}) \cap R_{ISN_{QN}}\}$; $R_{SNSP} = R$; $R_{SNSN_{QN}} \neq R$; $R_{ISN_{QN}} \neq R$.

In turn, firstly, **(quasi)natural singular plane substructures** in (2) correspond to model

$$\{SNSP\} \in \{LS \cap PGS \cap BS \cap PDS \cap OSPS\} \quad (3)$$

namely they combine such substructures of ecological network modeling region (*ENMR*), as:

1) **Landscape substructures (*LS*)** – taxonomic units of genetic-morphological landscape territorial structure of the regional level, such as stows (*ST*) and sub-stows (*SST*), wherefrom

$$\mathrm{D}\{LS\} = \{LS(\omega_{LS},R_{LS},t)\} = \\ \{ST(\omega_{ST},R_{ST},t) \cap SST(\omega_{SST},R_{SST},t)\} \quad (4)$$

where $\boldsymbol{\omega_{LS}}$, $\boldsymbol{\omega_{ST}}$ and $\boldsymbol{\omega_{SST}}$ – registering number for random subfields of appropriate substructures in (4); R_{LS}, R_{ST} and R_{SST} – spatial subfields' subareas of these substructures considering that total spatial area of landscape substructures is $R_{LS} \equiv R \in \{R_{ST} \cap R_{SST}\}$ and $R_{ST} \in \{R_{SST}\}$;

2) **Physical-geographic substructures *(PGS)*** – certain level units of physical-geographic zoning ([1]), especially physical-geographic areas *(PGA)* and districts *(PGD)* considering that they belong to zones *(PGZ)*, subzones *(PGSZ)* and lands *(PGL)* with correspondence to formalized notation

$$\mathrm{D}\{PGS\} = \{PGS(\omega_{PGS},R_{PGS},t)\} = \{PGZ(\omega_{PGZ},R_{PGZ},t) \cap \\ \cap PGSZ(\omega_{PGSZ},R_{PGSZ},t) \cap PGL(\omega_{PGL},R_{PGL},t)\} \cap \\ \cap PGA(\omega_{PGA},R_{PGA},t)\} \cap PGD(\omega_{PGD},R_{PGD},t)\} \quad (5)$$

where ω_{PGS}, ω_{PGZ}, ω_{PGSZ}, ω_{PGL}, ω_{PGA} and ω_{PGD} – registering number for random subfields of appropriate substructures in (5); R_{PGS}, R_{PGZ}, R_{PGSZ}, R_{PGL}, R_{PGA} and R_{PGD} – spatial subfields' subareas provided that total spatial area of *PGS* is $R_{PGS} \equiv R \in \{R_{PGZ} \cap R_{PGSZ} \cap R_{PGL} \cap R_{PGA} \cap R_{PGD}\}$;

3) **Basin substructures *(BS)*** – on the one hand, a totality of *basin territorial substructures (BTS)*, from the

higher rank basins (BTS_1) up to the lower rank basins (BTS_n); on the other hand, *basin morphological-positional substructures (BMPS)*, i.e. identified within selected rank *BTS* watershed-plain (*WPG*), slope (*SLG*), terrace (*TRG*), floodplain (*FPG*) and riverbed (*RBG*) geosystems, and, very often, their combinations (*CMPS*). Following the logic of previous formalization, it's possible to note that

$$D\{BS\} = \{BS(\omega_{BS},R_{BS},t)\} = \{BTS(\omega_{BTS},R_{BTS},t) \cap \cap BMPS(\omega_{BMPS},R_{BMPS},t)\}, \quad (6)$$

$$D\{BTS\} = \{BTS(\omega_{BTS},R_{BTS},t)\} = = \{BTS_1(\omega_{BTS,_1},R_{BTS,_1},t) \cap \ldots \cap BTS_n(\omega_{BTS,_n},R_{BTS,_n},t)\} \quad (7)$$

$$D\{BMPS\} = \{BMPS(\omega_{BMPS},R_{BMPS},t)\} = = \{WPG(\omega_{WPG},R_{WPG},t) \cup SLG(\omega_{SLG},R_{SLG},t) \cup \cup TRG(\omega_{TRG},R_{TRG},t) \cup \cup FPG(\omega_{FPG},R_{FPG},t) \cup RBG(\omega_{RBG},R_{RBG},t) \cup (\cap) \cup (\cap)\ CMPS(\omega_{CMPS},R_{CMPS},t)\} \quad (8)$$

where ω_{BS} ... ω_{CMPS} – registering number for random subfields of appropriate substructures in (6)-(8); R_{BS} … R_{CMPS} – spatial subareas of these subfields considering that total spatial area of *BTS* subfields is $R_{BTS} \equiv R \in \{R_{BTS,_1} \cap \ldots \cap R_{BTS,_n}\}$ and of *BMPS* subfields $R_{BMPS} \equiv R \in \{R_{WPG} \cup \ldots \cup (\cap)\ R_{CMPS}\}$;

4) **Positional-dynamic substructures (*PDS*)** – the units of positional-dynamic zoning ([1, 2]), i.e. para-dynamic areas *(PDA)* and subareas *(PDSA)*, landscape tiers *(LTI)*, basin and para-genetic sectors *(BPGS)* and landscape strips *(LSTR)*, which permits to make formalized notation

$$D\{PDS\} = \{PDS\ (\omega_{PDS},R_{PDS},t)\} = \{PDA(\omega_{PDA},R_{PDA},t) \cap \cap PDSA(\omega_{PDSA},R_{PDSA},t) \cap LTI(\omega_{LTI},R_{LTI},t)\} \cap \cap BPGS(\omega_{BPGS},R_{BPGS},t)\} \cap LSTR\ (\omega_{LSTR},R_{LSTR,}t)\} \quad (9)$$

where ω_{PDS} ... ω_{LSTR} – registering number for random subfields of appropriate substructures in (9); R_{PDS}, R_{PDA}, R_{PDSA}, R_{LTI}, R_{BPGS} and R_{LSTR} – spatial subareas of these subfields provided that total spatial area of positional-dynamical substructures is $R_{PDS} \equiv R \in \{R_{PDA} \cap R_{PDSA} \cap R_{LTI} \cap R_{BPGS} \cap R_{LSTR}\}$ etc.;

5) **Other (quasi)natural singular plane substructures (*OSPS*)** – accessory under modeling substructures, which characterize geographic-botanic, zoological-geographic, geologic, hydrogeological, relief-forming, soil and other regional peculiarities, including combined by attributes.

Secondly, **(quasi)natural singular network biocentric substructure ($SNSN_{QN}$)** in (2) is identical to reconstructed (retrospectively reproduced) elements of regional **(quasi)natural biocentric-network landscape territorial structure ($BNLTS_{QN}$)** (see [1, 2]), such as **bio-centers (BC_{QN})**, **bio-corridors (BCR_{QN})** and **interactive elements (IEL_{QN})**, herefrom

$$D\{SNSN_{QN}\} \equiv D\{BNLTS_{QN}\} = \{BNLTS_{QN}(\omega_{BNLTS_{QN}},R_{BNLTS_{QN}}t)\} = \{BC(\omega_{BC_{QN}},R_{BC_{QN}},t) \cup \cup BCR(\omega_{BCR_{QN}},R_{BCR_{QN}},t) \cup IEL(\omega_{IEL_{QN}},R_{IEL_{QN}},t)\} \quad (10)$$

where $\boldsymbol{\omega_{BNLTS_{QN}}} \ldots \boldsymbol{\omega_{IEL_{QN}}}$ – registering number for random subfields of appropriate substructures in (10); $R_{BNLTS_{QN}}$ … $R_{IEL_{QN}}$ – spatial subareas of these subfields given that $R_{BNLTS_{QN}} \neq R$.

Thirdly, **(quasi)natural integrated network bio-landscape substructure (ISN_{QN})** in (2) can be identified with a totality of network connected elements forming **(quasi)natural bio-landscape territorial structure ($BLTS_{QN}$)**, namely, from the one hand, reconstructed patches of *LS* (stow and sub-stow geosystems), *BMPS* (terrace-floodplain geosystems etc.) and $BNLTS_{QN}$ considering general background of (quasi)natural singular plane substructures. On the other hand, properly $BLTS_{QN}$ (quasi)geosystems are **regional (quasi)natural cores (*QNC*) and corridors (*QNCR*) of bio-landscape diversity** which serves as region's **quasi-natural (reconstructed) frame of bio-landscape diversity ($RFBLD_{ENMR}$)**. Herefrom

$$D\{ISN_{QN}\} \equiv D\{BLTS_{QN}\} \equiv D\{RFBLD_{ENMR}\} = \{BLTS_{QN}(\omega_{BLTS_{QN}},R_{BLTS_{QN}},t)\} = = \{RFBLD_{ENMR}(\omega_{RFBLS_{ENMR}},R_{RFBLS_{ENMR}},t)\} = = \{QNC(\omega_{QNC},R_{QNC},t) \cup QNCR(\omega_{QNCR},R_{QNCR},t)\}\ \forall \forall\{SNSP(\omega_{SNSP},R_{SNSP},t)\} \quad (11)$$

where $\boldsymbol{\omega_{BLTS_{QN}}} \ldots \boldsymbol{\omega_{SNSP}}$ – registering number for random subfields of appropriate substructures in (11); $R_{BLTS_{QN}}$ … R_{SNSP} – spatial subareas of these subfields provided that $R_{BLTS_{QN}} \neq R$.

NAS and AS in (1) should be considered as **regional functional structure of nature management (*RFSNM*)** with the further division on natural-anthropogenic and anthropogenic **regional functional and nature management substructures (*RFNMS*)**, such as agro-industrial (*AIS*), industrial (*IS*), settlement (*SS*), transport (*TRS*), nature-protective (*NPS*) and multi-recreational (*MRS*) substructures, therefore

$$D\{NAS \cup AS\} \equiv D\{RFSNM\} \equiv D\{RFNMS\} = \{RFNMS((\omega_{RFNMS}),R_{RFNMS},t)\} = \{(AIS(\omega_{AIS},R_{AIS},t) \cup \cup IS((\omega_{IS}),R_{IS},t) \cup SS(R_{SS},t) \cup TRS(R_{TRS},t) \cup NPS(\omega_{NPS},R_{NPS},t)) \cap MRS(\omega_{MRS},R_{MRS},t)\} \quad (11)$$

where ω_{RFNMS} … ω_{MRS} – registering number for random subfields of appropriate substructures in (12); $R_{RFNMS}…R_{MRS}$ – spatial subareas of subfields in (12) considering that $R_{RFNMS} \equiv R$.

In particular, *NPS* in (12) includes objects of nature conservation fund (*NCF*) and biotic-protective (*BPS*), other special protective (*OSPS*) and ecological network (*ENS*) substructures, that's why

$$D\{NPS\} = \{NPS(\omega_{NPS},R_{NPS},t)\} = = \{NCF(\omega_{NCF},R_{NCF},t) \cap (\cup)\ BPS(\omega_{BPS},R_{BPS},t) \cup (\cap) \cup (\cap)\ OSPS(\omega_{OSPS},R_{OSPS},t) \cap (\cup)\ ENS(\omega_{ENS},R_{ENS},t) \quad (13)$$

where ω_{NPS} … ω_{ENS} – registering number for random subfields of appropriate substructures in (13); R_{NPS} … R_{ENS} – spatial subareas of these subfields given that $R_{NPS} \neq R$ and *BPS* substructures are both point and polygonal spatial features and groups of these features (see [4]).

In turn, ecological network substructures in (13) will agree with general notation $\{ENS\} \in \{NLEN \cap (\cup)\ ISN_{ANA} \cap (\cup)\ MEN\}$ and therefore they include at regional scale:

1) **Substructures of national (inter-regional) and local ecological networks' elements (*NLEN*)**, considering a level of their conservation status implementation;

2) **Actual natural-anthropogenic integrated network bio-landscape substructure (ISN_{ANA})**, which is identical to **actual natural-anthropogenic bio-landscape territori-**

al structure (*$BLTS_{ANA}$*) (see for comparison (11)). Therefore the last one represents connected and/or, more often, disconnected patches of synergistically integrated certain *QNS* components, which are preserved (first of all "with human assistance") in close to natural state under conditions of anthropogenic pressure and impact of structure-destroying natural factors and/or are already restored. Such patches include actual elements of landscape and basin substructures (SST_{ANA}, ST_{ANA} and $CMPS_{ANA}$) and (quasi)natural biocentric-network landscape territorial structure ($BNLTS_{APA}$) and also proper components of nature-protective substructures (*NCF*, *BPS* and *OSPS*) considering general composition of other *RFSNM* elements (see (12)). In this case (quasi)geosystems of $BLTS_{ANA}$ are **regional actual natural-anthropogenic cores (*ANAC*) and corridors (*ANACR*) of bio-landscape diversity** which form region's **actual frame of bio-landscape diversity (*$AFBLD_{ENMR}$*)**, preserved in close to natural state. Wherefrom

$$\begin{aligned} &D\,\{ISN_{ANA}\} \equiv D\,\{BLTS_{ANA}\} \equiv D\,\{AFBLD_{ENMR}\} = \\ &\{BLTS_{ANA}(b_{ets_{ANA}}, R_{BLTS_{ANA}}, t)\} = \\ &= \{AFBLD_{ENMR}(\omega_{AFBLD_{ENMR}}, R_{AFBLD_{ENMR}}, t)\} = \\ &\{ANAC(\omega_{ANAC}, R_{ANAC}, t) \cup \\ &\cup ANACR(\omega_{ANACR}, R_{ANACR}, t)\} \ \forall \\ &\forall\ \{RFNMS((\omega_{RFNMS}), R_{RFNMS}, t) - NPS(\omega_{NPS}, R_{NPS}, t)\} \end{aligned} \qquad (14)$$

where $\omega_{BLTS_{ANA}} \dots \omega_{NPS}$ – registering number for random subfields of substructures in (14); $R_{BLTS_{ANA}} \dots R_{NPS}$ – spatial subareas of subfields in (14) given that $R_{BLTS_{ANA}} \neq R$ etc.;

3) **Modeling regional ecological network (*MEN*)** regarded, firstly, as a set of $BLTS_{ANA}$ and/or $BLTS_{QN}$ (quasi)geosystems, initially identified and finally selected according to specified system of bio-landscape diversity analysis' criteria for the purpose of current or perspective conservation and/or restoration and protection of such (quasi)geosystems as future ecological network's components. Secondly, *MEN* structure can be extended by proper additional artificial elements of nature-protective substructures (NPS_{ADD}) that may provide optimal composition and formation of future ecological network. All mentioned *MEN* components are earmarked to support implementation and sustainable functioning of region's **optimally formed frame of bio-landscape diversity (*$OFFBLD_{ENMR}$*)**, which is the most close to such (quasi)natural frame (see (11)). Properly structural elements ((quasi)geosystems) of MEN are **regional ecological network cores (*EC*) and corridors (*ECR*)** and their **buffer zones (*BZ*)**, herefrom

$$\begin{aligned} &D\,\{MEN\} = \{MEN(\omega_{MEN}, R_{MEN}, t)\} = \{EC(\omega_{EC}, R_{EC}, t) \cup \\ &ECR(\omega_{ECR}, R_{ECR}, t) \cup BZ(\omega_{BZ}, R_{BZ}, t)\} = \\ &= \{OFFBLD_{ENMR}(\omega_{OFFBLD_{ENMR}}, R_{OFFBLD_{ENMR}}, t)\} \ \forall \\ &\forall\ \{lim\ (OFFBLD_{ENMR}(\omega_{OFFBLD_{ENMR}}, R_{OFFBLD_{ENMR}}, t)) = \\ &= (RFBLD_{ENMR}(\omega_{RFBLD_{ENMR}}, R_{RFBLD_{ENMR}}, t) \cup \\ &\cup NPS_{ADD}((\omega_{NPS_{ADD}}), R_{NPS_{ADD}}, t))\} \end{aligned} \qquad (15)$$

where $\boldsymbol{\omega_{MEN}} \dots \boldsymbol{\omega_{NPS_{ADD}}}$ – registering number for random subfields of substructures and elements in (15); $R_{MEN} \dots R_{NPS_{ADD}}$ – spatial subareas of subfields in (15).

It should be remembered during modeling that ecological network cores and corridors in (15) have to be selected and analyzed as possible and then as final with their further division into prior and perspective for creation, including their relevant buffer zones.

Results and discussion. Considering the above preconditions, new algorithm of regional ecological network modeling contains the number of specified by criteria operations aimed at consistent creation, coordination and transformation of defined model structures with simultaneous forming and information saturation corresponding blocks of GIS database "Regional Ecological Network". Such structures are:

1) **Model structure *MS-1*** – the result of investigating region boundaries determination, wherefrom

$$\{MS\text{-}1\} \equiv \{R\} \in \{R_{QNS} \cap (R_{NAS} \cup R_{AS})\} \qquad (16)$$

2) **Model structure *MS-2*** – ordered set of definite (quasi)natural singular substructures under model

$$\begin{aligned} &\{MS\text{-}2\} \in \{QNS(\omega_{QNS}, R_{QNS}, t) - \\ &- (BLTS_{QN}(\omega_{BLTS_{QN}}, R_{BLTSQN}, t)\} \end{aligned} \qquad (17)$$

3) **Model structure *MS-3*** – the structure of bio-landscape diversity "frame" reconstruction and initial selection of possible *MEN* elements in accordance with notation

$$\begin{aligned} &\{MS\text{-}3\} \in \{BLTS_{QN}(\omega_{BLTS_{QN}}, R_{BLTS_{QN}}, t)\} = \\ &\{RFBLD_{ENMR}(\omega_{RFBLD_{ENMR}}, R_{RFBLD_{ENMR}}, t)\} = \\ &= \{QNC(\omega_{QNC}, R_{QNC}, t) \cup QNCR(\omega_{QNCR}, R_{QNCR}, t)\} \equiv \\ &\equiv \{EC_{PQN}(\omega_{EC_{PQN}}, R_{EC_{PQN}}, t) \cup EC\text{-} \\ &R_{PQN}(\omega_{ECR_{PQN}}, R_{ECR_{PQN}}, t)\} \end{aligned} \qquad (18)$$

where $EC_{PQN}(\omega_{EC_{PQN}}, R_{EC_{PQN}}, t)$ and $ECR_{PQN}(\omega_{ECR_{PQN}}, R_{ECR_{PQN}}, t)$ – the first set of possible *MEN* cores and corridors as reconstructed by modeling cores and corridors of $BLTS_{QN}$;

4) **Model structure *MS-4*** – the structure of region's anthropogenic transformation degree, presented as

$$\begin{aligned} &\{MS\text{-}4\} \in \{RFNMS((\omega_{RFNMS}), R_{RFNMS}, t) - \\ &- BLTS_{ANA}(\omega_{BLTS_{ANA}}, R_{BLTS_{ANA}}, t) - \\ &- MEN(\omega_{MEN}, R_{MEN}, t)\} \end{aligned} \qquad (19)$$

5) **Model structure *MS-5*** – the structure of bio-landscape diversity frame (quasi)geosystems' actualization according to equation

$$\begin{aligned} &\{MS\text{-}5\} \in \{BLTS_{ANA}(\omega_{BLTS_{ANA}}, R_{BLTS_{ANA}}, t)\} = \{AF\text{-} \\ &BLD_{ENMR}(\omega_{AFBLD_{ENMR}}, R_{AFBLD_{ENMR}}, t)\} = \\ &= \{ANAC(\omega_{ANAC}, R_{ANAC}, t) \cup ANACR(\omega_{ANACR}, R_{ANACR}, t)\} \equiv \\ &\equiv \{EC_{PANA}(\omega_{EC_{PANA}}, R_{EC_{PANA}}, t) \cup EC\text{-} \\ &R_{PANA}(\omega_{ECR_{PANA}}, R_{ECR_{PANA}}, t)\} \ \forall\ \{MS\text{-}3\} \end{aligned} \qquad (20)$$

where $EC_{PANA}(\omega_{EC_{PANA}}, R_{EC_{PANA}}, t)$ and $ECR_{PANA}(\omega_{ECR_{PANA}}, R_{ECR_{PANA}}, t)$ – the second set of possible *MEN* cores and corridors as differentiated by modeling cores and corridors of $BLTS_{ANA}$;

6) **Model structure *MS-6*** – the structure for analysis of natural-frame significance and state level concerning both sets of possible *MEN* cores and corridors by (19) and (20) and selection of the first set with final (principal) *MEN* cores and corridors (**$EC_{FIN,P,1}$** and **$ECR_{FIN,P,1}$**) in accordance with notation

$$\begin{aligned} &\{MS\text{-}6\} \in \{(EC_{PQN}(\omega_{EC}, R_{EC}, t) \cup ECR_{PQN}(\omega_{ECR}, R_{ECR}, t)) \cap \\ &(\cup)\ (EC_{PANA}(\omega_{EC}, R_{EC}, t) \cup \\ &\cup ECR_{PANA}(\omega_{ECR}, R_{ECR}, t)) \cap (RFNMS((\omega_{RFNMS}), R_{RFNMS}, t) - \\ &NPS(\omega_{NPS}, R_{NPS}, t))\} = \\ &= \{(MS\text{-}3) \cap (\cup)\ (MS\text{-}5) \cap \\ &\cap (MS\text{-}4)\} \equiv \{EC_{FIN,P,1}(\omega_{EC_{FIN,P,1}}, R_{EC_{FIN,P,1}}, t) \cup \\ &\cup ECR_{FIN,P,1}(\omega_{ECR_{FIN,P,1}}, R_{ECR_{FIN,P,1}}, t)\} \end{aligned} \qquad (21)$$

7) **Model structure *MS-7*** – the structure for $OFFBLD_{ENMR}$ first variant creation (see (15)) by addition and coordination with *MS-6* of required NPS_{ADD} elements and approximate *BZ* computation by notation

$$\{MS\text{-}7\} \in \{(MS\text{-}6) \cup NPS_{ADD}(\omega_{NPS_{ADD}},R_{NPS_{ADD}},t)) \cup \cup BZ(\omega_{BZ},R_{BZ},t)\} \equiv \equiv \{OFFBLD_{ENMR}(\omega_{OFFBLD_{ENMR}},R_{OFFBLD_{ENMR}},t)\}_{\mathrm{VAR1}} \quad (22)$$

8) **Model structure *MS-8*** – the structure for $OFFBLD_{ENMR}$ second variant creation by division of *MEN* cores and corridors and their buffer zones from (22) into prior (subscript "$_{PR}$") and perspective (subscript "$_{PP}$") according to equation

$$\{MS\text{-}8\} \equiv \equiv\{OFFBLD_{ENMR}(\omega_{OFFBLD_{ENMR}},R_{OFFBLD_{ENMR}},t)\}_{\mathrm{VAR2}} \in \in \{(EC_{PR}(\omega_{EC_{PR}},R_{EC_{PR}},t) \cup \cup ECR_{PR}(\omega_{ECR_{PR}},R_{ECR_{PR}},t) \cup BZ_{PR}(\omega_{BZ_{PR}},R_{BZ_{PR}},t)) \cup \cup (EC_{PP}(\omega_{EC_{PP}},R_{EC_{PP}},t) \cup \cup ECR_{PP}(\omega_{ECR_{PP}},R_{ECR_{PP}},t) \cup BZ_{PP}(\omega_{BZ_{PP}},R_{BZ_{PP}},t))\} \quad (23)$$

Prospects for further research are to improve the systematization of bio-landscape diversity analysis criteria regarding peculiarities of their application to model structures (16)-(23) adequate to proposed algorithm, to modify geoinformation-technologic approaches to implementation of mentioned algorithm and to verify developed model solutions on example of representative region's ecological network.

Conclusions. The conceptual bases for geoinformation modeling of regional ecological networks were developed by formalized structuring of the region into (quasi)natural, anthropogenic-natural and anthropogenic structures, their further differentiation into substructures and modeling of these substructures' dynamics, which allows to generate an optimally formed frame of region's bio-landscape diversity.

New algorithm of ecological network modeling contains number of specified by criteria operations aimed at consistent creation, coordination and transformation of defined model structures with simultaneous forming and information saturation corresponding blocks of GIS database "Regional Ecological Network".

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Маляренко А., Самойленко В. Региональные экологические сети: развитые подходы к геоинформационному моделированию

Аннотация. Получили развитие концептуальные основы геоинформационного моделирования региональных экологических сетей с обоснованием нового алгоритма, по которому такие сети последовательно моделируются из совокупности (квази)геосистем актуальной природно-антропогенной или (квази)природной биоландшафтной территориальной структуры с добавлением новых искусственных природоохранных элементов. Результатом моделирования должны стать сетевые экологические ядра и коридоры с их буферными зонами, которые разделяются на первоочередные и перспективные для создания и должны поддерживать оптимально сформированный каркас биоландшафтного разнообразия региона.

Ключевые слова: *биоландшафтная территориальная структура, (квази)геосистема, региональная экологическая сеть, экологическое ядро и коридор, геоинформационное моделирование*