Creation of Artificial Landscapes Spatial Systems Optimizing Human Habitat on Southern Coasts of the Russian Far East

S Yu Golikov, V I Petukhov, I S Maiorov
Department of Life Safety in Emergencies and Environment Protection, Far Eastern Federal University, 8 Sukhanova St., Vladivostok 690090, Russia
E-mail: golikov.sy@dvfu.ru

Abstract. The features of artificial landscapes’ spatial systems created for the optimization of industry facilities and settlements (as well as forest and agricultural crops taking into account the optimality of the existing microclimate and the possibilities for its improvement) are discussed in the paper. They improve the population health (through the optimization of the environment of settlements), the health of farm animals, the state of crops (through optimization of the climate), watercourses and forests reducing catastrophes on the shores and slopes by the proper selection and placement of species for artificial planting. They are achieved by revegetation, greening, garden and landscape design. In general, their purpose is to optimize the human environment.

1. Introduction
Artificial landscapes are an example of the intensive nature management model using eco-friendly technologies. These are the models for creating spatial systems designed to optimize the human habitat. Spatial systems of artificial landscapes only start to emerge in cities and settlements, but from there they transfer onto all man-made landscapes, improving the habitat and increasing the value and productivity of any land. The creation of spatial systems of artificial landscapes helps in solving the problems of wind and water erosion, marine cooling fogs or languorous fogs in July-August in the south of the Far East region, the transfer of surface runoff into the underground, destruction of shores, landslides, avalanches and mudflows, severity, monotony of landscape.

2. Methods
The creation of spatial systems of artificial landscapes is used for various purposes, according to which the following methods are applied: revegetation, landscaping, garden and landscape design. In order to substantiate the sustainable nature management, we proposed a natural-centered approach. For the reduction of the man-caused press on natural systems, we proposed eco-friendly technologies. The assessment of ecosystem degradation in the region was carried out mainly for vegetative communities of certain territories (using the rating system of the transformation and degradation of vegetation).

3. Results and discussion
The modern urban planning and the creation of industrial zones in recent decades is under the strict dictate of fulfilling international and voluntarily assumed obligations of Russia to comply with environmental standards (which is due to the implementation of the concept of sustainable
development). All this takes place against the background of the transition to a new postindustrial civilization and requires a change in the nature management paradigm, since the current practice of rational nature management, intensive economic and environmental management can economically develop the region, but not ensure its sustainable development [1-6]. The need for a transition to a sustainable nature management strategy based on renewable bioresources is proved by numerous economic calculations. For example, when comparing the value of oil production and fishing, the calculations show that after huge investments in oil production, incomparably greater than those in fishing, oil production will for a year yield the same income as fishing for 2 years. At the same time, the prospects for oil production are finite, and fishing is infinite [2].

We have proposed a scheme for the implementation of sustainable nature management [7], which is the complete opposite of the “rational nature management” scheme (nature management – recreation – nature protection complex). The nature protection complex is put in the first place with the goal to conserve and restore biodiversity, which is of primary economic interest (the gene pool and the protection of resources from all kinds of violations of legislation – poachers and users of natural resources with legal licenses that violate the rules of logging and exploitation of subsurface resources) as the basis for the sustainable well-being. The second place is the creation of buffer zones and recreational systems (recreational nature management – for the separation of nature protection complexes from areas of intensive nature management and the reduction of man-induced press); with resource and industry nature management completing our scheme.

The mechanism for implementing sustainable nature management is a nature-centered model that ensures the conservation of ecosystems (even in the zone of intensive economic management). After all, according to the law of G.F. Hilmi [4], an individual system operating in an environment with a lower level of organization than the level of the system itself is doomed, as gradually losing its structure, the system will dissolve in the environment after a while. When human beings violate natural territories (during the construction of infrastructure: railways, highways, oil and gas pipelines and other objects), an artificial localization of complex unique ecosystems occurs, which are simplified and doomed to gradual degradation. However, if the focus of the nature management system is on the specially protected natural areas that are nailed into the region planning system and they are fenced off from the zone of intensive economic nature use by a buffer zone (of various recreations), then there are no simplifications and degradations of ecosystems [8,9].

In connection with the new concept of sustainable nature management, advanced scientific eco-friendly and information technologies will be in demand for the recording and conservation of the biodiversity and bioresources. Consequently, the knowledge of the environment and biogeography will prove to be in demand by the users of nature as well, that is, by those whose development of natural resources was previously hindered by this knowledge [8].

The creation of spatial systems of artificial landscapes is a part of the sustainable nature management mechanism. The basis for the implementation of spatial systems of artificial landscapes in the Far East of Russia was the typology of landscapes by A.G. Isachenko [5] and our [10-17] rating assessment of the transformation and degradation of vegetation in the region. The assessment of ecosystem degradation in the region was carried out mainly for vegetative communities of the territories (using the rating system of the transformation and degradation of vegetation). During the transformation (reversible changes in the density of coenopopulations and the structure of communities during man-caused and generally short recovery periods that take place in the life cycle of one or a few generations of the forest), the composition of the biological diversity communities is stable, and the system returns to the original structure naturally. For example, a significant part of the liana-hornbeam, linden broadleaf and some of the oak forests in the vicinity of Vladivostok are in the transformation series: there is an intensive natural and artificial (subordinate crop) restoration of Manchurian fir and Korean pine. Beyond the progressive successions there are irreversible changes, occurring when the entropy curve of the flora abruptly decreases, and the communities loose the coniferous forest forming species and whole groups of species, that is, the vegetation degrades (the transition to a lower level of organization, both structure-wise and in the composition of communities).
The degraded communities include long-lasting secondary forests, brushwoods and meadows. At the stages of degradation, the severity of environmental problems typically decreases, since the most valuable elements of cenoses fall out of the system, and there is nothing to protect. The degradation of vegetation is suggested to be taken into account together with the transformation, evaluating the variability of natural landscapes units from 0 to 6, and marking them on the map with corresponding symbols. The rating of 0-3 corresponds to the transformation, 4-6 – to the degradation of the vegetation cover.

Artificial landscapes are an example of the intensive nature management model using eco-friendly technologies. These are the models for creating spatial systems designed to reduce the man-caused press on natural systems and optimize the human environment; they can aid in developing both production facilities and settlements, as well as forest and agricultural crops, taking into account the optimality of the existing microclimate and the possibilities for its improvement. These models are important [17] in large settlements (with their contamination of soil, water and air, and wind blowing through many streets). They are necessary to strengthen the slopes and shores (together with the appropriate planted trees). They are used in landscape design and for anti-avalanche and anti-mudflow plantations (especially in the Kamchatka Territory, Sakhalin Region, and in part in the Magadan Region). It is generally accepted [1] that the creation of spatial systems of artificial landscapes is expedient first of all in large settlements with their contamination of soil, water and air, and wind blowing through many streets, the need for slope and shore fortification, together with the appropriate planted trees, as well as the necessity of landscape design. However, on the coasts there is a common need for anti-avalanche and anti-mudflow plantations (for example, in the Sakhalin, Kamchatka, and partly in the Magadan regions). Avalanche risk, soil loss, strong winds and wind erosion, slope wash and stream-bank erosion, landslides harm all types of forest and agricultural land, and engineering reclamation does not always correct the situation [12]. Consequently, spatial systems of artificial landscapes only start to emerge in cities and settlements, but from there they transfer onto all landscapes utilized by man, improving the habitat and increasing the value and productivity of any land [17].

Based on the review of numerous experimental studies, as well as our own observations, we recommend:

1. To improve the habitat:
   1). In the Far East Region with its monsoon winds and the frequent changes in their direction, even during one day, a dense network of windbreak strips is desirable. Since the wind speed drops by 35-40% in the fields with a system of primary and secondary strips, the effect of the construction of the strips is 0.8 (dense), 1.0 (openwork), 1.2 (wind-blown) [10]:
      - dense multi-row protective strips around settlements, except for a few rows of fast-growing poplars, ash trees, walnuts (the Manchurian walnut in conditions of rich, not overmoistened and not drying up land has a height growth of 1.5-2 m per year!), should include at least 3 medium but well-lit rows of fast-growing conifers that require special treatment (otherwise poplars will deprive them of light);
      - openwork strips should have at least 3 rows of tall trees (for example, poplars, larch, fir trees) and 2-3 rows of berry bushes, placed so that the gaps along the entire profile of both trunks and crowns are not less than 15 and not more than 35%;
      - wind-blown forest belts should only consist of rows of trees with open-type gaps in the near-ground part (the area of gaps along the trunks, or between the trunks is more than 60%, between the crowns – no more than 10%).
   2). In the south of the Far East Region coniferous trees can be planted at the south side immediately behind the rows of berry and flowering bushes, from the shady side planting the Korean pine, Ussurian pear, species of cherry tree, maple, and maybe linden, as well as Nanking cherry bushes, currant, mock orange, deutzia, dog rose (these forest belts need to be accompanied by mineralized strips renewed every fall) [11].
3). The wind in the area of the monsoon climate in the south of Primorye during the warm period is predominantly blowing in the south-east direction [13], that is why the main protective strips should extend from the north-east to south-west, and in the case of a large river valley with prevailing winds – alongside it (the strips should block off the valley).

4). When settlements are located in the valley, openwork and wind-blown windbreak strips should be arranged at a 45-90° angle to the prevailing wind.

2. To stop the growth of ravines, we suggest using:
   1). Slope afforestation:
      a) in the south of the Far East Region – lianas;
      b) the species that:
         • grow an extensive root system, and after harvesting wood grow from the stump again (ash tree, Manchurian walnut, maple, linden, poplar);
         • yield workable wood, fruit, drug raw materials – burr woods and shrubs (aspen, bird cherry, sea buckthorn, false acacia, amorphoph);
   2). Seeding oak acorns in areas of 1-2 m² sites across 3-5 m (5-6 seedlings are placed at the site or about 20 acorns are sown).

3). Steep slopes of ravines can be terraced for plantations (adding burr plants along the ledges, including robinia, amorphoa, sea buckthorn).

4). Afforestation of the bottoms of ravines with poplar and larch species.

5). Forest plantations along the watercourses are determined by the substrate, the duration of the flooding, and the heat supply of the area and are not necessarily created with willows and poplars. Here hard-wooded broadleaved species can be used (Amur acacia, cork tree, walnut, ashtree) and in the absence of flooding in the south of the Far East Region – Manchurian fir, Korean pine, larch *Larix lubarskii*, prickly castor-oil tree, mountain ash, Sargent Cherry.

3. For anti-avalanche planting we suggest using fast-growing breeds with strong and elastic trunks and a firmly anchored tap root system, for example, Chosenia, poplar and tall willow species, including invasive plants, larch, Manchurian and ailanthus-leaved walnuts, Manchurian ash (preferably that of the Sakhalin population), Sakhalin cork tree, prickly castor-oil tree, bird cherry, Mongolian oak – at the coasts with snowy winters (south of 48°N); as well as larch, Erman's birch, Asian white birch, fragrant poplar – in the north of the Far East Region.

4. To optimize the placement of residential and industrial complexes in accordance with the microclimate of the sites:
   1). Consider regional features:
      a) since the microclimate at different directions of slopes of the low mountains of the Altai, the Sayan, the Malkhan Range (Buryatia) and the Bureja Range (the Amur Region) and the Primorye is very different, the patterns of variation in humidity and air and soil temperatures are often opposite:
         • southern, southwestern, western slopes are warmer and more dry throughout the year; northern slopes are warmer than the valleys; afforested slopes in general are warmer than treeless slopes, although the multistoreyed forest not so much softens the microclimate as it decreases the summer heat and winter frosts;
         • valleys of large rivers most often create wind tunnels reducing the yield of agricultural crops and the productivity of forest plantations, increasing the temperature drops, and contributing to frost weathering;
         • smoke and dust factors weaken in the valleys with intensive wind blowing and mixing of air, and the gaps in the wind shadow always remain warmer and more favorable, including for housing and cattle farms;
      b) in the areas with monsoon-oceanic and oceanic climate (Sakhalin, the coasts of the Northern Sikhote-Alin, the Kurils, the east of Kamchatka, the Komandorskie Islands), it is recommended to take into account not the exposure of the slopes, but their “turn” towards cold winds and fogs and the cooling or heating effect of currents, the distance from the shore and absolute height above the sea [3]:
the western and eastern shores of Sakhalin, Kurils, Kamchatka are unequal in this respect (in the summer, as a rule, western shores and high levels of sea terraces elevated at least by 100 m are more favorable); it is the effect of coastal micro-zones, when subalpine elfin wood and heath thicket, consolidated subalpine forest-steppe vegetation and taiga or taiga-broadleaf complex climb from the supralittoral level to the sea terraces and slopes [15], which is caused by disintegration, separation of communities that were brought together due to the tectonic submersion of land the cold stadials under the conditions of inversion of temperatures near the cold sea;

c) the western shore of the Kunashir is more favorable for life, but historically it is almost uninhabited since the era of construction of fish processing enterprises in the beginning and in the first half of the XX century (perhaps these amazingly beautiful places, rich in magnolia groves near hot springs, will be some day chosen by wealthy senior citizens, especially since there are opinions on the invigorating properties of local hot springs and mineral baths, their rejuvenating effect);

d) we propose the creation of garden-protecting forest belts, because:
- the air temperature in the clearings and glades of pine and oak forests of Primorye often exceeds 34°C in July-August (in the sunlight at a height of 2 m above the soil surface), and the temperature of the soil surface under the same conditions reaches 75 ° (southern, southwestern, western exposure of slopes; the Ilistaya River basin [16]), and in the forest these temperatures are not more than 28-30°C and 57-60°C, correspondingly;
- on the northern slope the air temperature reaches 27-29° in open spaces at an altitude of 2 m, at the soil surface – 37°C, in the forest – 27-28°C and 33-35°C. Consequently, the protective effect of even not very tall tree vegetation (the average height of the stand is only 15 m, the crown density is 0.6) is more pronounced on the sunny slopes, as it reduces the summer heat by 18-20%, doing almost the same to the frost in winter).

2). Residential buildings and farms should be positioned towards south and southwest [13] with blind northern walls, taking into account the restrictions of the location of buildings (at least to the south of 53°N). Their facades and facade groups closest to them are characterized by overheating, drying up, the inability to grow trees and lianas demanding constant considerable humidity, limiting the landscape gardening to xeromesophilic pines, stone fruits, and lianas.

3). Use solar panels for heating and hot water.

5. For landscape design:
1). The basic species in the forest-steppe zone may be macrotherm xeromesophilic larch, pine, juniper, stone fruits, pomaceous fruit, invasive plant, whose ecological optimum falls within the active temperatures in the range of 23-35°C.
2). In the forest-steppe the landscape designers use in parks: regular pattern elements (axes of symmetry, water parterres; straight alleys, paths, borders, lawns, flower beds), picturesque elements (aesthetically pleasing, close to nature combinations of forests and meadows, rocks and ponds, hills and plains), functionality elements – revegetation (windbreaks, slope-fixing plants) and fruit gardens.
3). In the north of the zone the basis of the planted species will be nemoral species, including treelike junipers, black pine, Crimean pine, Japanese black pine, broad-leaved trees, various shrubs, flowering lianas and perennial plants.
4). In the south of the zone, landscape design focuses on subtropical species, including those with pyramid and umbrella crowns, junipers, cypress, false cypress, Crimean pine, Eldar pine, Lebanon cedar, flowering trees and lianas, walnut plantations, solid woods of exotic fast-growing conifers.
5). In the natural decorative landscapes area of the Far East Region we suggest:
- creating artificial plantings as copies of natural, particularly attractive ecosystems;
- recreating ecosystems contrasting in structure and composition, for example, enriched with more southern introduced species [12].
6). It is extremely important in the era of global warming of the climate to make the landscape more southern – eliminate its monotony by the restoration of coniferous areas, the introduction of large and broadleaved species, such as walnuts and horse chestnut.
7). For introduction and reintroduction we suggest to use hygrophilous conifer and broad-leaved species from the areas with monsoon-oceanic and oceanic climates of the south of the Far East.

8). In the south of the taiga zone the plants of nemoral genesis, variegated-leaved species, firs with blue needles, lianas, flowering perennials in regular and landscape plantings, and in the southern Sakhalin and Kurils – Engelmann spruce, magnolia, and lianas become promising due to the warming effect.

9). In the taiga area one should be guided by the taiga variegated-leaved floracoenotype, introduced from the North America (ash-leaved maple species), microthermal poplars, Erman's birch and its hybrids with Siberian yellow birch, conifers of the northern half of the Far East Region, in particular Kamchatka fir, and species with a broad environmental range – hybrid Kamchatka spruce, larches Larix ochotensis, Larix amurensis, Larix maritima.

10). In the northern taiga zone, the greening and landscape design should consider local chozenia, willows and poplars, partly introducing larches, Siberian spruce, Ajan spruce, cedar elfin wood, introduced mountain pine and Pinus parviflora (these pines originate from the mountains of Central Europe and Japan, accordingly), alder stands and subalpine junipers.

4. Conclusions

1. The creation of spatial systems of artificial landscapes:
   - corresponds to the modern requirements of industrial and civil urban development in the context of the sustainable development concept;
   - occurs against the background of transition to a new postindustrial civilization based on the environmental and economic priorities;
   - will help in preserving biodiversity, restoring old recreation zones and creating new ones and providing new jobs.

2. Spatial systems of artificial landscapes:
   - from cities and settlements they transfer onto all landscapes utilized by man, improving the habitat and increasing the value and productivity of any land;
   - help in solving the problems of wind and water erosion, marine cooling fogs or languorous fogs in July-August in the south of the Far East region, the transfer of surface runoff into the underground, destruction of shores, landslides, avalanches and mudflows, severity, monotony of landscape;
   - are achieved by revegetation, greening, garden and landscape design;
   - improve the health of the population (through the optimization of the environment of settlements), the health of farm animals, the state of crops (through the optimization of the climate), watercourses and forests, reducing catastrophes on the shores and slopes by proper selection and placement of species for artificial planting.

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