

## Improvement of Ecological Fon in Georgian Cities

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### ABSTRACT

*The article deals with the issues relating to the innovative technologies of green coverage arrangement on the roofs of the buildings and structures. there are widely represented the cover types and detailed characteristics of their structures. The appropriate conclusions are made, which describe the technical and environmental advantages of the green pavement arrangement. They show both, positive (Ecological, economic, psychological, business, security and aestheticism) and negative sides.*

**Key Words:** roof; green coverage; green plants; ecology.

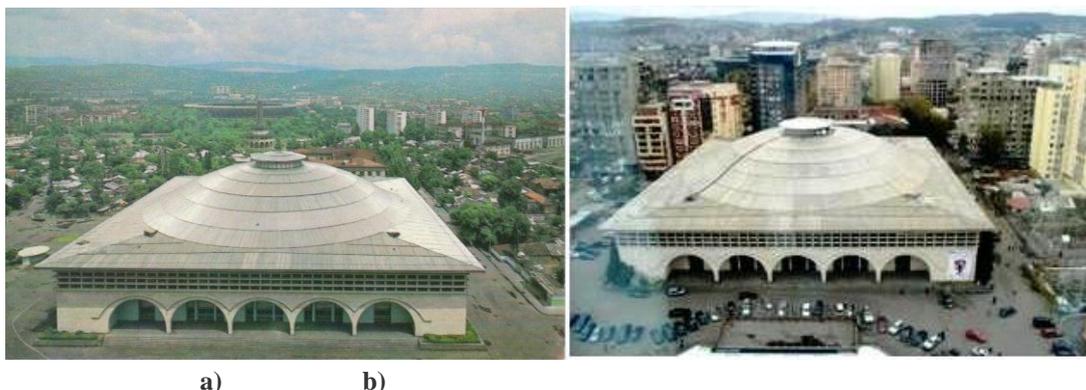
### Introduction

The human and nature relationship starts from the very biginning. Since then, people not only accepted surroundings but they have started its tranformation: cutting down forests, cultivated land, made build roads and bridges, new towns and so on. The big sities population growing and the science and technology developement made it easier for people to use nature.

Recently, a lot of houses were built and the most of them were built in the prestigious districts.

The density of constructions has distroyed the green areas. Dramatically increased the number of cars. The Sidewalks turned into car parkings. A large number of vehicles caused the air pollution. Due to the multi-storey building density they shade each-other and lighting standards are violated and many flats have no enough sunlight. Super urbanization has led to the deterioration of the living conditions of the people and the climate [1-5]. Especially heavy situation in Tbilisi city and environments of the city [6-9], where there is only an small quantity of recreational zones [10-12].

An integral part of urban life – parks and squares. Recreational areas around the city are deplorable. Extensive analysis of the environmental situation are not done. Ongoing constructions in the recreation areas, green zones and especially the prestigious districts (photo 1, 2, 3) start without environmental impact assessment documents. Nobody measures the noize, and no one discusses the greenery and ventilation issues. Considering this situation the urban planning ecology issue is becoming increasingly important. Moreover, the we talk about the million-city, which ecological situationis in a critical situation [8,13].



a)

b)

**Photo 1. Tbilisi Sports Palace surrounding area:  
a) XX century 80-s and b) Now**



a)



b)

**Photo 2. The former Hippodrome a) XX century, in the 80-s and b) now**



a)



b)

**Photo 3. The construction boom in Kipshidze street:  
a) view from the river Vere gorge; b) view from Chavchavadze Avenue**

## MAIN PART

At present situation of the ecological environment deterioration in big cities, it is very important the improvement of building design and construction.

In the big blocks of flats, where people feel themselves far from the nature there is possible to arrange the recreation area with plants, that can improve the buildings ecological situation [14].

In order to live more comfortable in the houses people used to build houses with green covering from the herbaceous plants that provided the protection of the microclimate of the houses.

In ancient times, gardens and small grass lawn leisure facilities were built 2,500 years ago in Assyrian and Babylon. The most obvious example is the Hanging Gardens of Semiramida. Gradually Hanging Gardens and green areas cultivation have begun not only in Asia, but also in Europe.

Scandinavian countries, particularly Norway, practice grass-covered areas over several centuries.

The green environment can make life comfortable conditions, which lead to ecological situation improvement (Improving the air, creating a micro-climate) As well as psychological and emotional rehabilitation capacity expansion.

Along with the growth of cities is becoming the one of the equally important aspects of the architecture - "the fifth facade" of buildings. The great problem of big cities is the Lack of free land and a big price. Green roofs are particularly important for the economic and ecological point of view.

In 1960 the German architect arranged the recreation area on the roof and called it "the green roof". Of course, the green roof is better than the traditional roof from the aesthetic and architectural points of view. Because, as a rule, the traditional roofs are not arranged in order to be aesthetic.

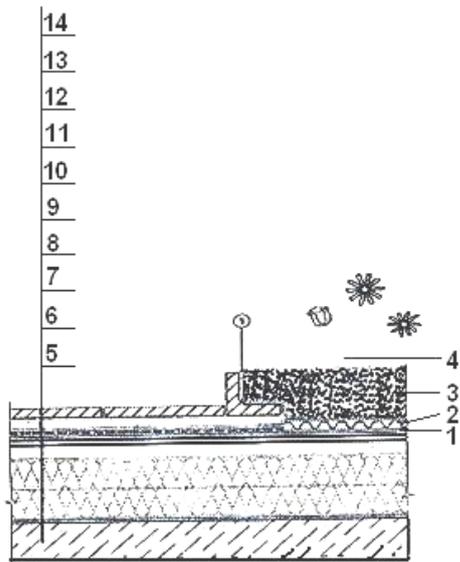
On the background of global climate change the developed countries such as North America and European countries, especially in metropolises (photo 4), have in their eco programs the green coverage arrangement. For example, the green roof is actively developing in cities such as Copenhagen, Paris, London, Berlin, New York, Chicago and others. There are many examples in Asia-Thailand, China and so on.



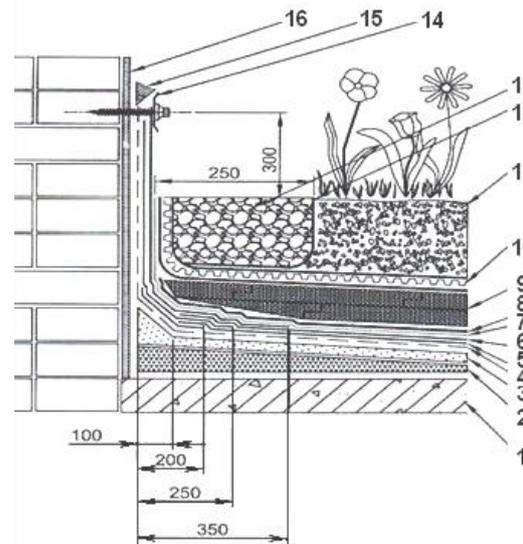
**Photo 4. Green coverage examples**

It's well known green coverage vegetation types, structures and diversity. Green coverage consists of 6 main layers: 1. Plant layer; 2. Soil substrates; 3. Filtration layer; 4. Drainage system; 5. waterproofing layer; 6. The insulation layer. In some cases, the composition or the material may be different (photo 5) [15,16].

The number of layers can change and be more in different cases due to the technologies (fig.1, 2).



**Fig. 1. The cover construction of greenery:**  
 1 – geotextile 350-400 g / m<sup>2</sup>; 2 - Planter life;  
 3 - ground; 4 - Greening; 5 - roofing tile; 6 - Steam insulation; 7 - hitter; 8 - reinforced cement-sand crust; 9 - bitumen primer; 10 –hydro isolation 2 layer; 11 -plastic layer;12 - Drainage component; 13 - reinforced cement-sand crust; 14 - sidewalks or floor tiles



**Fig. 2. green cover assent to wall:**  
 1 - roofing tile; 2 - lightweight concrete layer; 3 - reinforced cement-sand crust;4- primaries;5, 6 - 2 insulating layer; 7, 8 - geotextile;9 - foam polystyrene; 10 - drainage membrane; 11 - soil; 12 - Geotextile; 13 – Gravel a fraction 20-40 mm;14 - Marginal metal backed sealing strip; 15 - hermetick; 16 - plaster layer.

**2 kinds of geen coverage is known in modern designn: extensive and inverted [3].**

The extensive coverage (photo 5) is not used for walking. You can only walk on special places of this kind of coverage. The soil layer is not more than 0,07–0,15mm. Which gives us the chance to plant only small plants. Onli special kinds of greenery or moss can be planted here in the spesial capacities.

The plant must have the horizontal root system. The estensive coverage in water saturated condition is 80-100 kg/m<sup>2</sup> we can plant varetly of small, drought resistant plants.The soil is saturated with essential minerals. There are 80% of extensive green coverage in Germany because it can easily return the investment back and can bring great ecological and floodin protection benefits to the densely populated city.



**Photo 5. Green extensive roofs**

**Green intensive(inversive) roof** –is a construction, where we can arrange not only the lawn, but also the gardens with trees and bushes and maybe with fountains and pools (photo 6) the intensive roofs must have parapets minimal height 1.2 m and the soil height – 0.2 – 0.6 m.



**Photo 6. Green intensive roofs**

Green, intensive coverage other items (pools, fountains, benches, trees and so on) and the soil thickness usually increases the load on the roof bearing elements. Because of this they take into account the green coverage structure on the stage of designing. It must be accounted the weight of the construction.

Here is some of the structural composition of green coverage [17]:

**1. Green coverage plants selection** must be provided individually and depends on the environment, green coverage location, soil thickness and the customer's wish. They usually choose moss or grass for the green coverage, meadow flowers and mountain flowers depending on the building location and the climate conditions

**2. Soil Substrate.** For soil it's used the substrate, which is much lighter, than the soil (peat or something else). This can significantly reduce base load. The lightened green coverage construction is particularly relevant for intensive coverage arrangement.

**3. Filter layer** usually consists of geo textile and root protective shell. The geo textile is used as filtering layer to avoid leak of soil particles in drainage and avoid congestion (photo 7).



**Photo7. Geotextiles**

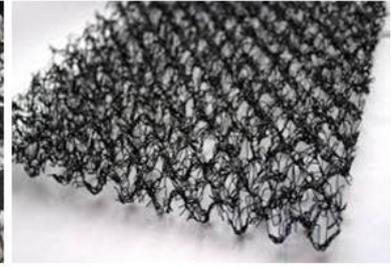
For the green coverage it's used the thermally hardened geo textile, the construction is made so that it practically can't be sledged and has a great operation period in given conditions. The root protective layer is arranged after the geo textile (photo 8), (preferably made of nonwoven polypropylene).It is not recommended concrete or asphalt-concrete layer for the root protected layer.

**4. Drainage system** can be performed in some options:

- Perforated drainage layer with using water pipes;
- Perforated polystyrene tiles;
- Gravel;
- Drainage layer (photo 9).



**Photo 8. Root protective layer**



**Photo 9. Drainage layer**

The perforated high strength polystyrol or plastic pipes made of high pressure are used as drainage pipes. During the drainage system arrangement the soil depth and average rainfall amount should be considered. The soil layer thickness is measured considering the plant layer root deepening. When we arrange the extensive covering, the root deepening is about 20 cm and the deep drainage is not necessary.

**5. Waterproofing layer** – is protecting the green coverage from water and moisture liking into the building or the building walls outer surface. The variety of membranes is used for the green coverage waterproof layer arrangement. For example,

- Polymer waterproofing membranes on bitumen base and anti-root protection (ecological material), photo 10;



**Photo 10. Polymer waterproofing membranes on bitumen base**

- Polymer- with anti-root protection based on synthetic (operating period of 60 years), photo 11;



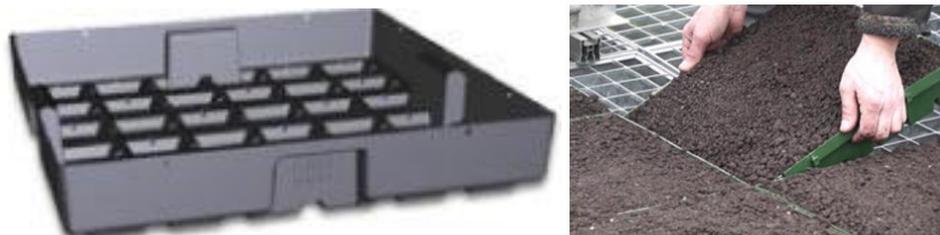
**Photo11. Polymer waterproof membrane arrangement on the synthetic base**

- Aluminum or copper foil with additional protective membrane;
- With liquid resins;

As rule, the waterproof layer on the flat roofs is arranged with 3-5% inclination.

**6. Insulation layer.** It's recommended to arrange the insulation layer from the glass foam or perlite sand. The glass-foam does not conduct the moisture and it is not toxic for plants and soil micro flora. The

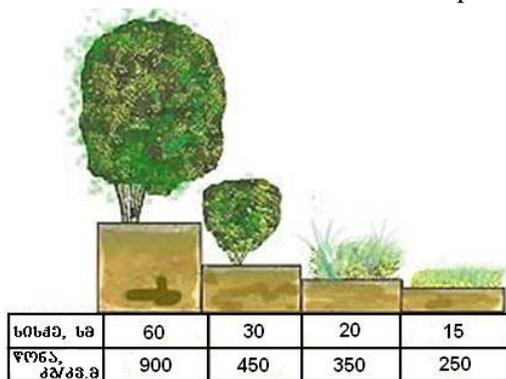
extruded polystyrene foam tiles and mineral wadding is used for hitting. They also put the soil into the small plastic boxes (0.5x0.5m) to simplify the job (photo 12).



**Photo 12. Plastic boxes for soil and the box arrangement**

Intensive green coverage differs from extensive one by the soil thickness and hitters placement- its situated on the waterproof layer, not under it. This can protect it from mechanical damage.

Photo 13 presents the chart which determines the roof load size dependence on soil layer thickness.



**Photo 13. The size of the load on the roof of green cover soil layer thickness and plant diversity**

The table below shows the relative data of two green coverages. The table shows, that the extensive coverage is better than intensive one:

- Relatively low price;
- less load on the coverage bearings;
- Easy storage and maintenance.

**Table**

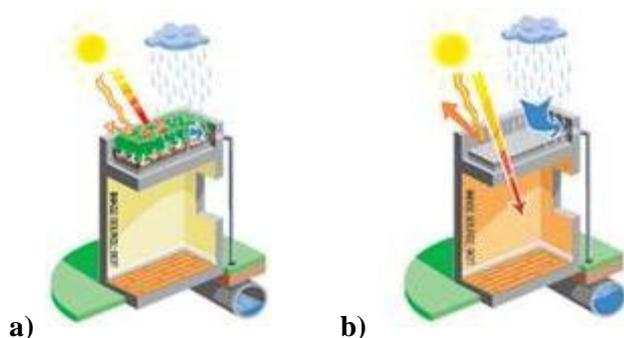
<b>Extensive greening</b>	<b>Intensive greening</b>
Does not provide being people on the covering	Gives possibility to arrange the garden on the green coverage, where people can walk
Plant monotony	Variety of bushes and trees
Don't need frequent watering and special care	It needs special care and watering as normal garden
Don't need frequent technical services	Needs good technical services
The coverage arrangement is possible on the roofs of various inclination	Gives possibility to locate flowers, bushes, trees, leisure zones, and pools on the roof.
Small weight	Medium and large weight
Possible arrangement on the existed buildings	Must be developed on the building design stage
Cheapness	High price

## Conclusion

The positive sides of green coverage arrangement – ecological, economical, psychological, business, security and aestheticism:

1. **Ecological situation improvement** - the plants of the green coverage reduce harmful substances in the air due CO<sub>2</sub> absorption and oxygen gas emissions. It's calculated, that 150 m<sup>2</sup> of green cover age allocates the oxygen that is enough for 100 people in a year. The green coverage plants neutralize the big amount of dust and harmful air, created favorable bioclimate [10-12,18,19]. 1000 m<sup>2</sup> of extensive green coverage can absorb 8 kg dust in a year, and air near the green coverage is fresh and includes the 37%-less SO<sub>2</sub> and 21%-less CO;
2. **Reduces the noise impact** (up to 8-10 dcb). The soil can absorb the low- frequency sounds and the plants can absorb the high-frequency sounds;
3. The green coverage also **moist air**. The coverage can deter or partially absorb 50-70% of rain water;
4. It 3-4 times **increases the coverage construction validity** because of the sun's ultraviolet rays and overheating protection (sun rays can hit the coverage up to 80°C). The green coverage arrangement can prolong the ordinary flat coverage life up to 60%. It's known, that the green coverage usage can save our expenses up to 60%;
5. Green coverage on the roofs is **fire prevention**;
6. Green coverage performs a natural function of the thermal insulation on this base **the energy costs reduce for heating and cooling of buildings**;
7. Green coverage can be used for vegetable or fruit **gardens, Industrial greenhouses or for the leisure zone; It can be arranged the football stadiums, Children's playground, cafe, restaurant, Terraced places for business meetings. All this can give extra income**;
8. This kind of coverage is very **aesthetically beautiful** – the green coverage of houses with beautiful flowers and green balconies can create the daily comfort;
9. The status will rise and will increase the value of real estate–Ecological house and a beautiful view **will increase the house price**;
10. Green cover **improves the microclimate** in the building too;
11. **It is important in terms of employment** because It's needed not only builders, architect and workers, but It is important to botanists, gardeners and environmental ists involvement;
12. If the green coverage design is high quality, and the construction is made due all the rules, than we can say that the green roofs **will return the investment** we put into the coverage and at the and, it will be much more cheaper than traditional roofing;
13. **The green coverage operational period length** – It's well known, that the temperature is very high on the traditional roof in summer. Hit often damages the insulating layer and we have to change them. In Georgia it's recommended to change the roof every 10-15 years but the green roofs operation length is about 50-70 years because of plants protection from sun rays and other kind of damages;
14. Existing channels in our cities can't provide a large amount of water to drain during heavy rains because there is no more greenery in our towns. We have huge buildings everywhere instead of gardens and parks. Large amount of water comes from the building roofs and joins torrents which become more affluent. At the same time, the drainage channels are polluted and the household waste, leaves and so on fall into the wells. All these damage ecosystem.

Regrettably, in Georgia, there is no study on loosing that carry the torrents but the fact is that heavy rains damage vehicles, electric wires, flats, people...For example, in 2010-2011, in Tbilisi children have died because of flooding. **One of the cheap ways** for the problem solving is green coverage. Green roof can absorb the rainfall and filter the water, as a result, there is a little amount of clean water in the drainage systems (photo 14).



**Photo 14. Water amount in the drainage system:**  
 a) in case of green coverage; b) in case of traditional roofing

15. Very often the planting of greenery is done by using the lawn rolls. There are some organizations in USA and European countries which have their own fields and they supplying stadiums, parks, yards and firms that organize green roofs of buildings. They make lawn rolls in the fields and than transport those into a construction work site (photo 15).



**Photo 15. Lawn rolls making abroad**

Roof arrangement in this way is a **quite effective business** in countries, where green roofs set aside for the construction legislation. Purchasing ready-made rolls, firm saves the time on plant growing and has green coverage arranging possibility at any time of year. But gardeners and botanists decide which the best time for sowing is.

## References

- [1] Budagashvili T., Karchava J., Gunia G., Intskirveli L., Kuchava T., Gurgenzidze M., Amiranashvili A., Chikhladze T. Inventory of Greenhouse Gas Emissions and Sinks. Georgia's Initial National Communication on Under the United Nations Framework Convection on Climate Change, Project GEO/96/G31, Tb., 1999, 137 p.
- [2] Amiranashvili A.G., Amiranashvili V.A., Gzirishvili T.G., Kharchilava J.F., Tavartkiladze K.A. Modern Climate Change in Georgia. Radiatively Active Small Atmospheric Admixtures. Institute of Geophysics. Monograph. Trans. of M. Nodia Institute of Geophysics of Georgian Acad. of Sc., ISSN 1512-1135, v. LIX, Tb., 2005, 128 p.
- [3] Tavartkiladze K., Begalishvili N., Kharchilava J., Mumladze D., Amiranashvili A., Vachnadze J., Shengelia I., Amiranashvili V. Contemporary climate change in Georgia. Regime of some climate parameters and their variability. Monograph, ISBN 99928-885-4-7, Tb., 2006, 177 p., (in Georgian).

- [4] Amiranashvili A., Chikhladze V., Kartvelishvili L. Expected Change of Average Semi-Annual and Annual Values of Air Temperature and Precipitation in Tbilisi. *Journ. of Georgian Geophysical Soc., Issue B. Physics of Atmosphere, Ocean and Space Plasma*, ISSN 1512-1127, v. 13B, Tb., 2009, pp. 50 – 54.
- [5] Amiranashvili A., Matcharashvili T., Chelidze T. Climate change in Georgia: Statistical and nonlinear dynamics predictions. *Journ. of Georgian Geophysical Soc., Iss.(A), Physics of Solid Earth*, v.15A, Tb., 2011-2012, pp. 67-87.
- [6] Stankevich S., Titarenko O., Amiranashvili A., Chargazia Kh. Determination of Atmospheric Aerosol Optical Depth over Territory of Georgia during Different Regimes of Cloudiness Using the Satellite and Ground-Based Measurements Data *Bulletin of the Georgian National Academy of sciences*, vol. 9, No. 3, 2015, pp. 91-95.
- [7] Stankevich S., Titarenko O., Amiranashvili A., Chargazia Kh. Modeling of Ozone Content Distribution in Lower Troposphere over the Territory of Georgia Using the Data of Satellite and Ground Observations. *Bulletin of the Georgian National Academy of sciences*, vol. 9, No. 2, 2015, pp. 54-58.
- [8] Amiranashvili A., Bliadze T., Chikhladze V. Photochemical smog in Tbilisi. *Monograph, Trans. of Mikheil Nodia institute of Geophysics*, ISSN 1512-1135, v. 63, Tb., 2012, 160 p., (in Georgian).
- [9] Amiranashvili A., Chargazia Kh. Intra-Annual and Seasonal Variations of Sub-Micron Aerosols Concentration and their Connection with Radon Content in Surface Boundary Layer of Tbilisi City. *Bulletin of the Georgian National Academy of Sciences*, vol. 10, N 2, 2016, p. 72-78.
- [10] Amiranashvili A.G., Bliadze T.G., Chikhladze V.A., Saakashvili N.M., Tarkhan-Mouravi I.D., Sikharulidze Sh.A., Lachashvili N.I. National Botanical Garden of Georgia – Recreational – Sanitation Oasis of Tbilisi City. *Trans. of the Institute of Hydrometeorology at the Georgian Technical University*, v. 117, ISSN 1512-0902, Tb., 2011, pp. 94-96.
- [11] Amiranashvili A., Bliadze T., Chikhladze V., Machaidze Z., Melikadze G., Saakashvili N., Khatiashvili E., Tarkhan-Mouravi I., Sikharulidze Sh., Nakaidze T., Tavartkiladze M. New Data About the Aeroionization Characteristics of the Territory of National Botanical Garden of Georgia as the Factor of the Expansion of its Sanitation Properties for the Visitors. *Journ. of Georgian Geophysical Soc., Iss. (B), Physics of Atmosphere, Ocean and Space Plasma*, vol.16b, Tbilisi, 2013, pp. 24-30.
- [12] Amiranashvili A.G., Amiranashvili V.A., Bliadze T.G., Tarkhan-Mouravi I.D., Chikhladze V.A. Content of Light Aeroions in Some Health Resort and Tourist Zones in Borjomi and Tbilisi. *Actual Problems of Pathology, Therapy and Medical Rehabilitation, Collection of Scientific Articles*, ISBN 978-9941-0-6499-9, Tbilisi-Moscow: TBR-RAM-TS, 2014, pp. 69-74.
- [13] Amiranashvili A., Khurodze T., Shavishvili P., Beriashvili R., Iremashvili I. Dynamics of the Mortality of the Population of Tbilisi City and its Connection with the Surface Ozone Concentration. *Journ. of Georgian Geophysical Soc., Iss. (B), Physics of Atmosphere, Ocean and Space Plasma*, vol.16b, Tbilisi, 2013, pp. 31-38.
- [14] TECHNISCHE REGELN. abc der Bitumenbahnen. Germany. Frankfurt/main, 2002, p. 83.
- [15] TECHNISCHE REGELN. abc der Bitumenbahnen. Germany. Frankfurt/main, 2007, p. 103-112.
- [16] Jordania T., Ezugbaia Z., Gvinefadze R. Roofs. Green coverage arranging technology. *GTU*, 2009, p. 225-227.
- [17] Catalog of the materials. *Technonikol. Moscow*, 2008, p. 255-257.
- [18] Amiranashvili A.G., Chikhladze V.A. Saakashvili N.M., Tabidze M. Sh., Tarkhan-Mouravi I.D. Bioclimatic Characteristics of Recreational Zones – Important Component of the Passport of the Health Resort – Tourist Potential of Georgia. *Trans. of the Institute of Hydrometeorology at the Georgian Technical University*, v. 117, ISSN 1512-0902, Tb., 2011, pp. 89-92.
- [19] Amiranashvili A.G., Bliadze T.G., Chikhladze V.A., Saakashvili N.M., Tarkhan-Mouravi I.D., Sikharulidze Sh.A., Lachashvili N.I. National Botanical Garden of Georgia – Recreational – Sanitation Oasis of Tbilisi City. *Trans. of the Institute of Hydrometeorology at the Georgian Technical University*, v. 117, ISSN 1512-0902, Tbilisi, 2011, pp. 94-96.

# ეკოლოგიური ფონის გაუმჯობესება საქართველოს დიდ ქალაქებში

ზ. ეზუგბაია, ი. ირემაშვილი

## რეზიუმე

სტატიაში განხილულია საკითხები, რომლებიც ეხება შენობების და ნაგებობების სახურავებზე მწვანე საფარის მოწყობის ნოვაციურ ტექნოლოგიებს. ფართოდ არის წარმოდგენილი ასეთი საფარის სახეები, დეტალურადაა მოცემული მათი კონსტრუქციული მახასიათებლები. ნაშრომში გაკეთებული შესაბამისი დასკვნები, რომლებიც ახასიათებენ ასეთი ბურულების მოწყობის ტექნიკურ და ეკოლოგიურ უპირატესობებს ჩვეულებრივ ბურულებთან შედარებით.

*საკვანძო სიტყვები:* სახურავი, ბურული, მწვანე საფარი, მწვანე ნარგავები, ეკოლოგია.

# УЛУЧШЕНИЕ ЭКОЛОГИЧЕСКОГО ФОНА В КРУПНЫХ ГОРОДАХ ГРУЗИИ

З.А. Езугбая, И.Р. Иремашвили

## Резюме

В статье рассмотрены вопросы касающиеся инновационной технологии по устройству зелёных покрытий на крышах зданий и сооружений. Широко представлены виды таких покрытий, в деталях даны их конструктивные характеристики. Сделаны соответствующие выводы, которые характеризуют технические и экологические преимущества таких кровель над обычными.

*Ключевые слова:* крыша, кровля, зеленое покрытие, зеленые насаждения, экология.