



**HAL**  
open science

# Environmental modelling of urban landscapes as complex, vulnerable and dynamically developing structures

Polina Lemenkova

► **To cite this version:**

Polina Lemenkova. Environmental modelling of urban landscapes as complex, vulnerable and dynamically developing structures. Biodiversity. Bioconservation. Biomonitoring, Adygea State University (ASU), Oct 2015, Maykop, Russia. 10.6084/m9.figshare.7211537.v2 . hal-01973758

**HAL Id: hal-01973758**

**<https://hal.science/hal-01973758>**

Submitted on 11 Jan 2019

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons CC0 - Public Domain Dedication 4.0 International License

2. Илюшкина Л.Н., Биологическая активность почв урболандшафтов г. Ростова-на-Дону и г. Азова: Автореф. дис... канд. биол. наук. Ростов-на-Дону, 2008. 25 с.
3. Методы почвенной микробиологии и биохимии. / Под ред. Д.Г. Звягинцева. М.: МГУ, 1991. 304 с.
4. Руководство по медицинской микробиологии. Общая и санитарная микробиология. Книга 1. / Под ред. А.С. Лабинской, Е.Г. Волиной. М.: БИНОМ, 2008. 1080 с.
5. Соловьева Е.С. Экологические особенности актиномицетных комплексов городских почв: Дис... канд. биол. наук. Киров, 2014. 147 с.

УДК 504.05(529)

**Lemenkova P.A.**

*Charles University in Prague, Institute for Environmental Studies, Czech Republic  
Карлов Университет в Праге, Институт экологических исследований, Чехия*

### **ENVIRONMENTAL MODELLING OF URBAN LANDSCAPES AS COMPLEX, VULNERABLE AND DYNAMICALLY DEVELOPING STRUCTURES**

### **МОДЕЛИРОВАНИЕ ОКРУЖАЮЩЕЙ СРЕДЫ ГОРОДСКИХ ЛАНДШАФТОВ – СЛОЖНЫХ, УЯЗВИМЫХ И ДИНАМИЧНО РАЗВИВАЮЩИХСЯ СТРУКТУР**

**Summary.** The study area is focused on the coastal city of Taipei. The environmental changes of the city were detected by geospatial analysis of the satellite images. The areas occupied by different landscape types were calculated and analyzed. It was detected that various districts were developing with different rate and intensity due to the complex factors of both human and ecological origin. The results showed intensive urban development, decline of green areas, increase of urban spaces since 1990.

**Аннотация.** Область исследования сосредоточена на прибрежном городе Тайбэй (Тайвань, Китай). Экологические изменения города были обнаружены с помощью геопространственного анализа спутниковых снимков. Площади, занимаемые различными типами ландшафта, были проанализированы. Было обнаружено, что разные части города развиваются с разной скоростью и интенсивностью из-за сложного сочетания антропогенных и природных факторов. Результаты показали процессы интенсивной урбанизации, деградацию зеленых ареалов, увеличение площадей застроенных территорий с 1990 года.

The study area is located in the city of Taipei, Taiwan (Fig.). Recently, the process of urbanization has become more notable in the East Asia. Since past decades, Taipei undergone serious urban changes as residential structure of the vacant land areas is developing and requires modifications. The development of urban landscapes in Taipei has unique feature; that is, the Taiwan's exceptional economic and industrial growth since 1980s, which is often referred as "industrial wonder of Taiwan". The country quickly transformed from an agriculture-based traditional economy into a highly industrialized society.

As a result, Taiwan has now a new face of high-technology oriented, economically restructured economy, which is a part of the global network of economies and capitals, playing important role both in the Asia-Pacific region and in the global production chains.

Necessarily, this caused notable changes in the face of the country, modifying both its social and natural landscape patterns. Thus, Taiwan is nowadays a highly urbanized country with almost 80% of the total population of Taiwan living in urban areas. However, intensive urbanization necessarily create new conditions for human-nature co-existence, since rapidly growing city and high urbanization rate affect biodiversity and ecosystems sustainability in the coastal area. The process of urbanization includes transformation of landscapes: natural land cover types, typical for the area are being modified into artificial surfaces and the area of city enlarges.

The landscape diversity is the most clear attribute of the landscape health and stability in the landscape ecology context since it responses to the urbanization and its relationships with other aspects of landscape.

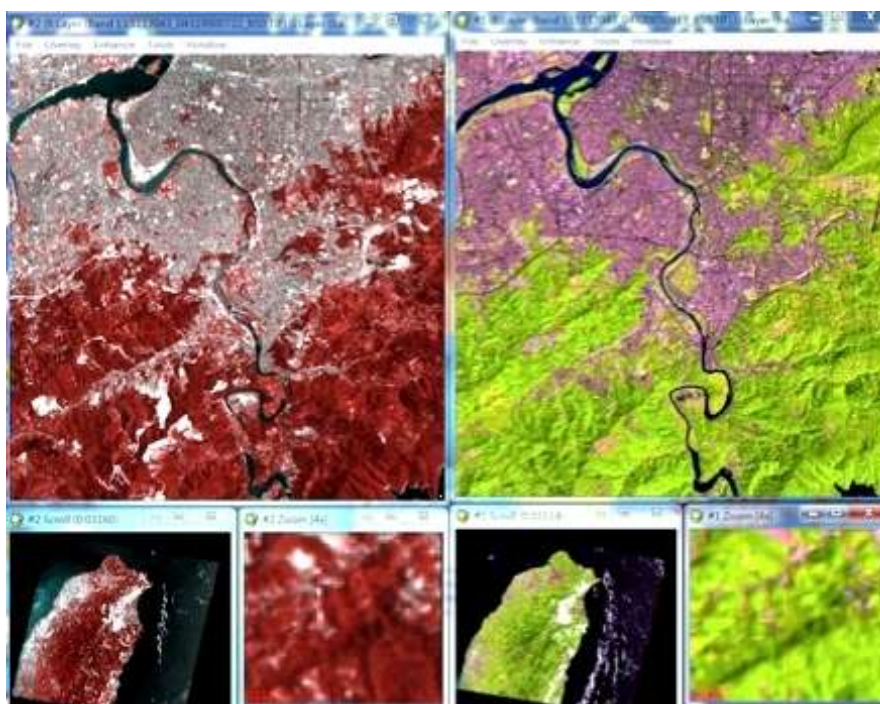


Fig. Study area of Taipei: Landsat TM images (1990 and 2005)

Therefore, the landscape diversity is considered as a crucial criterion in the planning and evaluation of the landscape (Kuiper, 1998, Ferguson, 1996). For instance, the landscape diversity was used to detect correlation between changes in landscape diversity and spatial pattern of landscape elements caused by land cover changes (Nagaike, Kamitani, 1999). Moreover, there is a significant correlation (75%) between the landscape diversity and degree of urbanization in Taipei city. Predictably, the landscape diversity is higher in the rural and less urbanized areas, while it increases in the urban areas due to the domination of the human-induced landscape types and reduced number of natural patches within the city.

The urban system of Taipei metropolitan region can be clustered into six homogeneous urban zones of ecological energetics demonstrating that urban center of Taipei is notable for the high level of consumption of non-renewable energy sources (water, petroleum, natural gas, fertilizers, electricity, etc.), high anthropogenic, economic and industrial impacts. Other consequences of urbanization include significantly altered

aboveground net primary productivity and soil respiration rates, compared with natural ecosystems (Kaye et al., 2005), air pollution and decreased water quality. The uncontrolled urbanization causes also gradual limitation of the land and water resources, which leads insufficient infrastructure within the city and consequently, contributes to the development of densely concentrated mixed types of land use. About 45% of the Taipei city is categorized as restricted with regard to availability and usage due to its topography, while only 14% (46.30 sq.km) is available for residential and commercial development (Tsou and Cheng, 2013). Nowadays, new city face consists of built-up new apartments, buildings, office centers, residential areas, re-structured districts. This process is reinforced by the average structure age of the buildings and modernization (Lin and Jhen, 2009). Overall, the city structure, such as streets configuration or public transportation networks, have a substantial impact on the face of urban landscapes. For instance, modification in the city planning in Taipei causes redistribution of

the urban activities which, in turn, affect landscapes (Lin et al., 2008).

Taipei urban landscape consists of different types of patches, including built-up areas and natural landscapes. The structure of landscape, shape and configuration of different land cover types change significantly according to the urban district location and the level of urbanization in this specific area. The classification of the land cover types in the Taipei metropolitan area includes following 10 major types: 1) Forests; 2) Wetlands; 3) Grasslands; 4) Open fields with little or no vegetation; 5) Rivers, channels; 6) Lakes, ponds; 7) Cultivated lands 8) Livestock farms, agricultural facilities; 9) Parks and squares; 10)

Urban built-up areas. Using physio-geographic and social data on Taipei, the region was divided into three distinct regions, as follows: Region I located on the left bank of Tamsui river, “agricultural” area; Region II the core, old city of Taipei; Region III the region located southwards from the core city. The calculation of the changes in the landscapes were performed for each area and each land cover type respectively. Using calculations of the land cover types that belong to the assigned areas on the classified images in 1990 and 2005 respectively, the results have been received and summarized in Tab.

Table – Calculated changes in land cover types within the city of Taipei.  
Comparison of landscape changes in urban area, 1990-2005

| Regions land cover types       | 1990, % | 2005, % |
|--------------------------------|---------|---------|
| Region I: “urban areas”        | 17,1    | 21,9    |
| Region I: “urban vegetation”   | 5,7     | 4,1     |
| Region I: “forests”            | 19,8    | 18,6    |
| Region I: “grasslands”         | 21,4    | 18,3    |
| Region II: “urban areas”       | 79,3    | 83,2    |
| Region II: “urban vegetation”  | 4,3     | 5,2     |
| Region II: “forests”           | 32,7    | 31,8    |
| Region II: “grasslands”        | 15,9    | 14,7    |
| Region III: “urban areas”      | 24,3    | 38,2    |
| Region III: “urban vegetation” | 3,7     | 4,3     |
| Region III: “forests”          | 42,4    | 41,8    |
| Region III: “grasslands”       | 13,8    | 12,1    |

**Acknowledgements:** Current research was financed and supported by the Taiwan Ministry of Education Short Term Research Award (STRA) for the author's two-month research stay at National Taiwan University, Department of Geography. Taipei, Taiwan (China).

#### Literature

1. Ferguson B.K., 1996. The maintenance of landscape health in the midst of land use change. *Journal of Environmental Management*, 48, 387-395.
2. Kaye, J.P., Mcculley, R.L., Burke, I.C., 2005. Carbon fluxes, nitrogen cycling, and soil microbial communities in adjacent urban, native & agricultural ecosystems. *Global Change Biology* 11, 575-587.
3. Kuiper, J., 1998. Landscape quality based upon diversity, coherence and continuity: landscape planning at different planning-levels in the River area of the Netherlands. *Landscape Urban Plan.* 43, 91-104.
4. Lin T.-C., Jhen M.-H. (2009) Inequity of land valuation in the highly developed city of Taipei, Taiwan. *Land Use Policy* 26. 662-668.

5. Lin Y.-P., Wu P.-J., Hong N.-M. (2008) The effects of changing the resolution of land-use modeling on simulations of land-use patterns and hydrology for a watershed land-use planning assessment in Wu-Tu, Taiwan. *Landscape & Urban Planning* 87, 54-66.
6. Nagaike T., Kamitani T., 1999. Factors affecting changes in landscape diversity in rural areas of the *Fagus Crenata* forest region of central Japan. *Landscape Urban Planning* 43, 209-216.
7. Tsou K.-W., Cheng H.-T. (2013) The effect of multiple urban network structures on retail patterns – A case study in Taipei, Taiwan. *Cities* 32, 13-23.

УДК 502.52(23)(470.62)

Рагульская Е.А., Криворотов С.Б.  
*Кубанский государственный университет*

### ИСПОЛЬЗОВАНИЕ ЛИХЕНОИНДИКАЦИОННЫХ МЕТОДОВ ДЛЯ СОХРАНЕНИЯ БИОРАЗНООБРАЗИЯ ГОРНО-ЛЕСНЫХ ЭКОСИСТЕМ СЕВЕРО-ЗАПАДНОГО КАВКАЗА

### USE OF THE LICHEN INDICATION FOR CONSERVATION OF THE BIODIVERSITY OF MOUNTAIN AND WOOD ECOSYSTEMS OF THE NORTHWEST CAUCASUS

**Аннотация.** Изучен систематический состав и таксономическая структура эпифитной лишенобиоты экосистем горно-лесного пояса Северо-Западного Кавказа. Выявлены эпифитные лишеносинузии исследуемого района и их распространение. Дана лишеноиндикационная оценка степени атмосферного загрязнения некоторых горно-лесных фитоценозов Северо-Западного Кавказа.

**Summary.** The systematic composition and taxonomic structure of epiphytic lichens in ecological systems of the mountain forest belt of the North-Western Caucasus have been studied. The epiphytic lichen sinusia and their distribution have been identified for the studied area. The assessment of air pollution of some mountain forest communities of the North-Western Caucasus using lichen indication is presented.

В последние десятилетия во многих странах заметно возрос интерес к проблемам индикационной экологии. В настоящее время в центре внимания биологов и экологов находятся механизмы воздействия, накопления и трансформации поллютантов на различных уровнях биологической организации. Реальная оценка ответной реакции каждого конкретного вида на антропогенные факторы, изучение этих изменений в различных формах и различными методами в итоге и составляет предмет экологической индикации, а применительно к лишайникам - лишеноиндикации.

В связи с усилением воздействия антропогенных факторов на горно-лесные фитоценозы актуальность исследования индикационной роли лишайников, как наиболее чувствительного компонента к загрязнению экосистем, резко возрастает. В горно-лесных

экосистемах Северо-Западного Кавказа значимую роль в сукцессиях играют эпифитные лишайники и лишеносинузии, которые являются хорошими биоиндикаторами загрязнения, так как под влиянием антропогенной нагрузки происходит заметная трансформация лишайниковых сообществ. Изучение группировок лишайников в лесных экосистемах может способствовать решению некоторых вопросов экологии и фитоценологии, сохранению биологического разнообразия горно-лесных экосистем Северо-Западного Кавказа. По видовому составу лишайников и лишеносинузий можно диагностировать влияние антропогенного загрязнения на развитие растительных сообществ, проводить длительный экологический мониторинг их состояния.

Маршрутные и стационарные исследования проводились 2011-2015 гг. в разных