

GIS-A Tool for Monitoring and Management of Epidemics

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Abstract: *Our aim is to identify, evaluate and catalogue Romanian ecosystems at risk and environmental conditions linked to global change, which can influence the spatial and temporal distribution and dynamics of West Nile virus. The project innovation integrates health-environment investigations combined with spatial data (satellite imagery) and with epidemiological data. The eco-geographical diversity of the project study areas covers relevant Romanian eco-systems. The virus circulation is studied within a scientific framework involving key-elements of the Landscapes, Vector and Parasite bionomics, Public Health, human activities and Animal Reservoirs and will be linked together by a series of integrative activities that include environmental change detection, disease modeling, remote sensing and image interpretation.*

Keywords: *GIS, Health-Environment, climate change, emerging (vector borne) diseases, epidemiological data, West Nile Virus (WNV), Satellite imagery, Land Cover/Land Use Classification System.*

1. Introduction

In recent years, several vector-borne, parasitic or vector-borne diseases have emerged or re-emerged in different part of the world, with major public health, socio-economic and political consequences. Emergence of these diseases linked to climatic change, human induced landscape changes and human activities that have affected disease ecology. Our teams illustrate geographic information system-based approaches to understand epidemiological processes and predict disease patterns. National approaches are used to explore vector and host distribution and identify areas where substantial changes in vector and vector-borne disease distributions have occurred. Introduction the pathogens into new areas may be the consequence of the land cover/land use. There has also been increased the opportunity the vectors to spread their historical distribution areas, via passive transportation (for West Nile virus-WNV the principal hosts are wild and resident birds) (9). In our researches we make a link between environmental change and public health (8).

This virus perceive in Romania from the region of West Nile (where was discovered the first infection with this virus in 1937) by the help of wild birds that perceive in Danube Delta and with their blood are feed mosquitoes (the virus is in their salivary glands).

Our researches aims are to identify, evaluate and catalogue some Romanian ecosystems and environmental conditions linked to global change, which can influence the spatial and temporal distribution and dynamics of human pathogenic agents. Through a coordinated approach, the researches will develop and coordinate, at the European level, a set of generic methods, tools and skills such as predictive disease emergence and spread models, and will identify requirements for

early warning, surveillance and monitoring tools and scenarios, which can be used by decision makers for risk assessment, decision support for intervention and public health policies at either the EU, the national or regional level. Part of these results will be to combine spatial data (earth observation data, GIS etc) with epidemiological data.

The infections by WNV were and are present in Romania and the circulation of the virus was intensified in the last years.

In the past decade there have been a number of outbreaks of West Nile Virus (WNV) in Europe. Little is known of the transmission of this virus in the region, so it is uncertain whether these episodes are part of an erratic pattern of transmission or evidence of a change in long-term prevalence. The recent, rapid spread of West Nile Virus (WNV) in North America (44 US states and 6 Canadian provinces in 5 years) indicates that we should not be complacent about the European WNV situation (5, 1). The principal researcher is to improve our understanding of the natural history of the virus and its vectors in Romania and to assess the potential for transmission under future conditions of climate and environmental change. The investigations have the goal to explore the impact of environment changes and other reasons to re-emerging of human WN infections transmitted by mosquitoes, which represent an important health problem for Romania.

The objectives of our research are as follows:

- to understand area-wide past WNV transmission patterns and related environmental events through the analysis of historical time series of climate and environmental data for observed WNV foci throughout Romania and for similar areas outside such foci, in WNV-outbreak and on-outbreak years and use the obtained outputs to assess the public health significance of WNV;
- to characterize the environmental determinants correlated with WNV transmission in 3 areas from Romania distributed in (Danube Delta and lagoons, Bucharest and Ilfov and Giurgiu counties and Banat region) through a landscape structure analysis and use a landscape epidemiological approach to describe vector/host habitats where West Nile Virus transmission has been documented;
- to integrate information gathered through historical time series analysis and high resolution epidemiological studies in order to construct area-wide statistical models for the occurrence of WNV in Romania, from which to derive public/veterinary health recommendations.

2. Results and methods

We have identified, evaluated and catalogue the risk ecosystems from Romania and the environment conditions generated by climate changes that can influence the spatial and temporal distribution and dynamic of WNV.

Our team made complex investigations by the transmission cycles of WNV from different types of ecosystems from Romania and the integration by the evolution data, especially the climate changes and others environmental changes. We completing the GIS data base of LC/LU in the 3 areas of interest (Danube Delta and lagoons, Bucharest and Ilfov and Giurgiu counties and Banat region) for a better spatial analysis and integrated the data for WNV circulation by this localization.

Also we have evaluated the meteorological conditions (humidity and temperature) from the period before the outbreak of WNV infections and especially in the years after the outbreak from 1996 in South of Romania (11).

For our research we have used a comparative study of **Land Cover /Use Classification System (FAO) - LCCS/US** from maps 2000 and 2003 (4). **Land Cover /Use Classification System - LCCS/US** is a complex methodology for describe, characterization, classification and comparison of different types of land cover. The **LCCS/LU** maps were realized by using data from comparison and interpretation of satellite images and topographical maps.

The satellite images utilized for LC/LU maps were offered by following satellites:

Satellite system	Data of image acquisition	Spatial resolution
Landsat – 7 ETM	May-July 2000	15 m – panchromatic 30 m - multispectral
Landsat – 5 TM	June – August 2003	30 m - multispectral
Landsat – 5 TM	June-July 1998	30 m - multispectral
QuickBird	June 2003	0,6 m

We have used satellite images Landsat – 5 TM from the period June-August 2003 at high resolution for land cover classification and change detection and modeling these data with vector, host human data in a spatially-explicit way. We have modeled vector/host presence/absence, abundance and serological prevalence, as well as human cases infection.

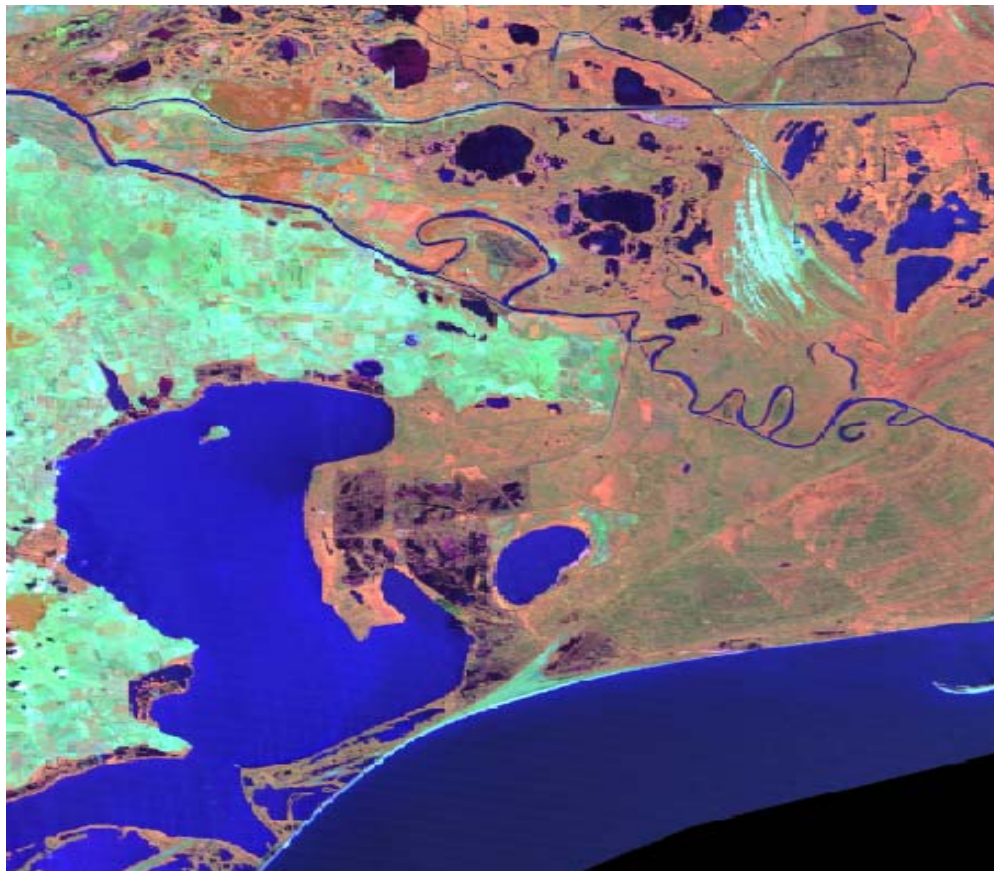


Fig. 1 Satellite image of Danube Delta and lagoons (area of interest) – Landsat-5TM - 2003
 Topographical and thematically maps were:

Maps	Scale	Type	Cover
Topographical maps	1:50 000	Raster – black/white	all country
Topographical maps	1: 100 000	Raster - Color	all country
Thematically maps	1: 200 000	Raster - Color	Danube Delta
Thematically maps :geomorphologic, vegetation, hydrological	1: 500 000	Raster - Color	all country

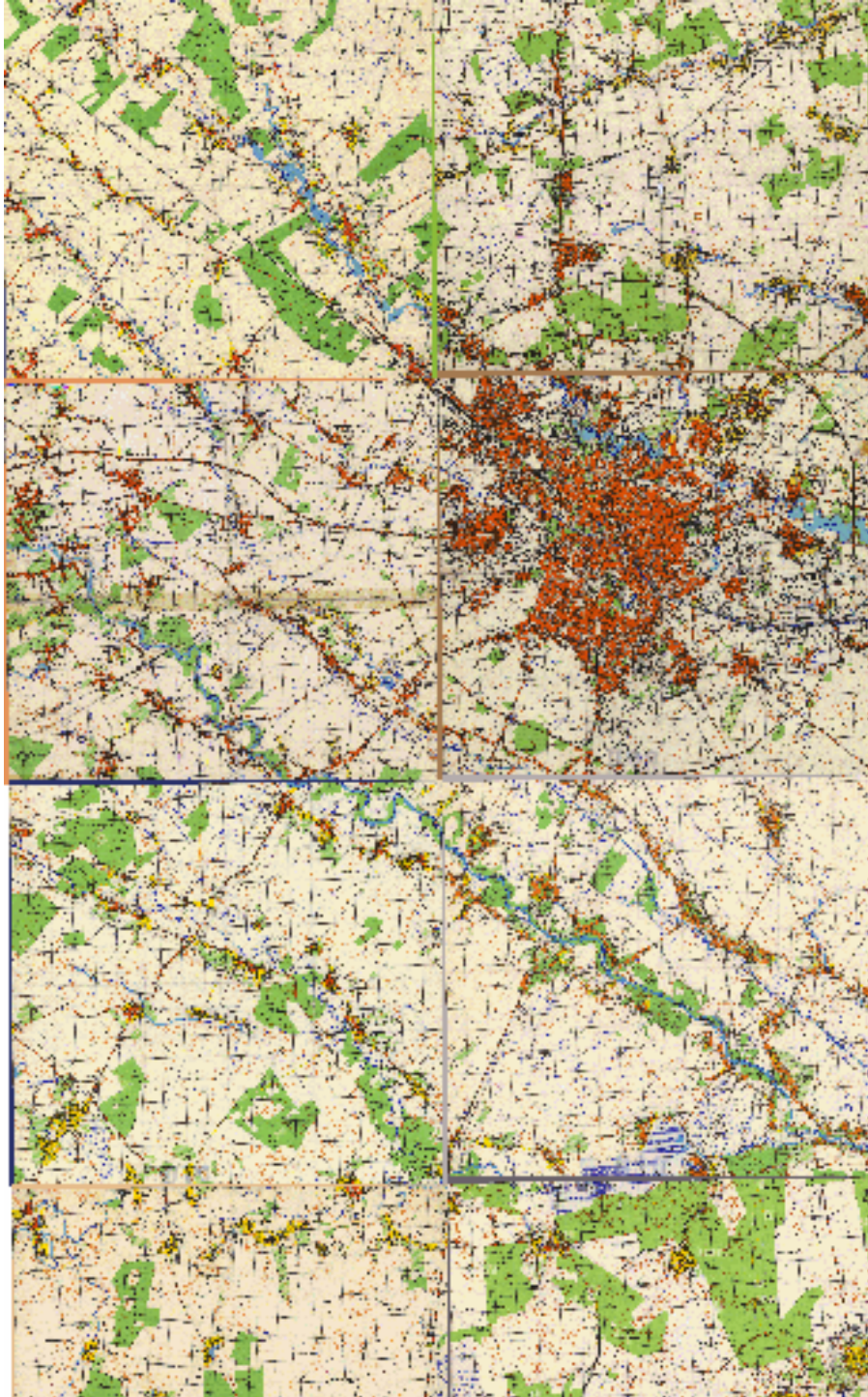


Fig. 2 Topographical map of Bucharest and Ilfov and Giurgiu counties (area of interest)

LCCS maps were realized by ERDAS Imagine, Arc View, MS Access, Arc GIS, Geo VIS, LCCS using the following layers:

- 1. Satellite images - multispectral*
- 2. Satellite images – panchromatic*
- 3. Topographical maps at scale 1:50.000 and 1:100.000*

4. *Vegetation Index – NDVI (Normalized Difference Vegetation Index) – a derivation of satellite images*

5. *Digital map FAO-LCCS.*

LC classes are grouped in 10 units (names are in English according to LCCS) (4).

LCCS/LU maps according to LCCS-FAO System. Digitizing was realized at scale 1:50.000 added land trips and using high resolution images (HR – High Resolution) or very high using high resolution images (VHR – Very High Resolution).

The satellite images and the field data offered a better way to understand the outbreaks and re-emerging of diseases like West Nile Virus infection linked by climate factors.

For better spatial analyses of the circulation of West Nile virus we used "ESA's ERS Programme: a Summary Status report on SAR Data Distribution and Applications"- Proceedings of the Workshop Use of ERS-1 SAR Data for Agricultural, Forestry and Environmental Applications in Central-Eastern Europe, ESA Nile Virus" and realized maps by geographical distribution of human registrant cases in the years 1964, 1996 and in the period 1997-2000 (6).

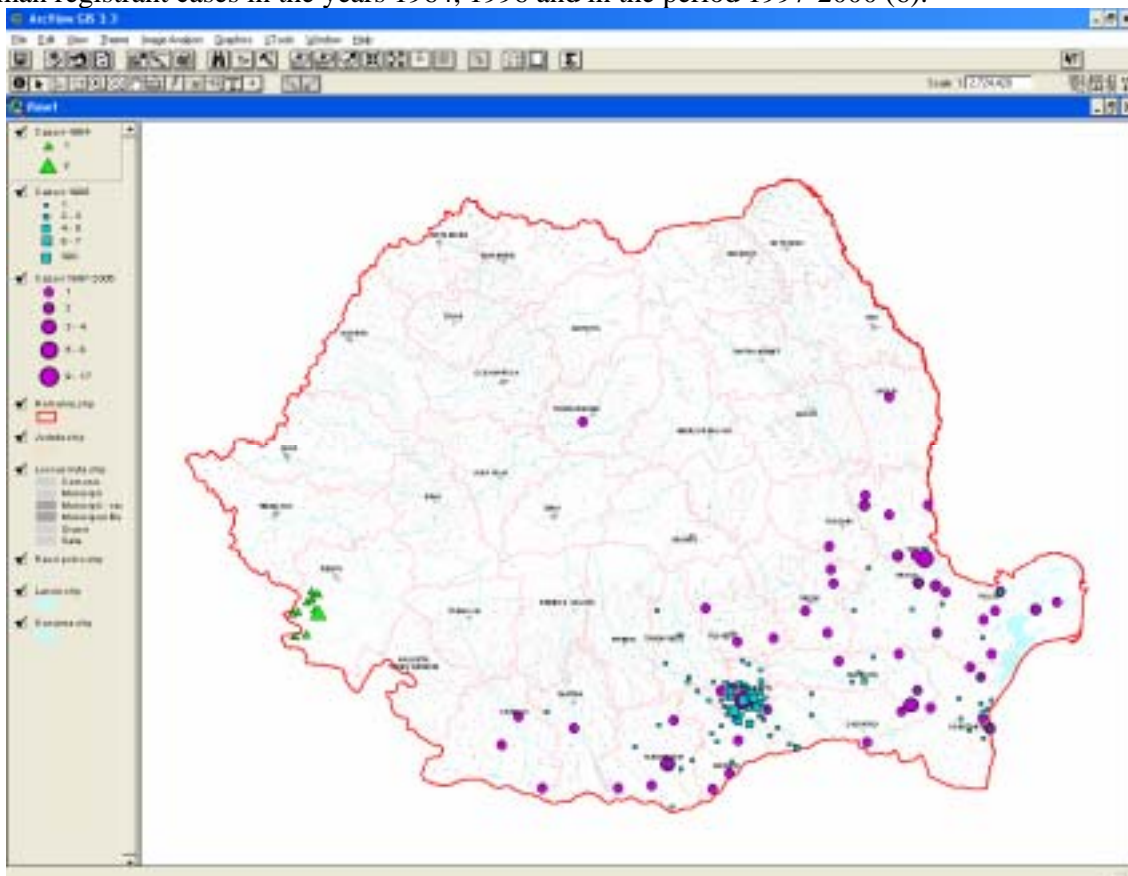


Fig. 3 Distribution of human cases in Romania in 1964, 1996 and 1997-2000

The greatest numbers of human cases of WNV infection were in the region of Bucharest (and the surrounding areas) and in the Danube Delta. In the Banat Plane (floods from 2005) there is no case until now.

In order to obtain the Romanian LCCS/LU maps we utilized satellite images and topographical maps.

For our task we have made a comparison between the LCCS/LU maps from 2000 (Summer) and 2003(Summer) for 3 areas of Romania to indicated the possible habitats of West Nile vectors (mosquitoes) and main hosts (wild and resident birds)and secondary hosts (horses and human being).

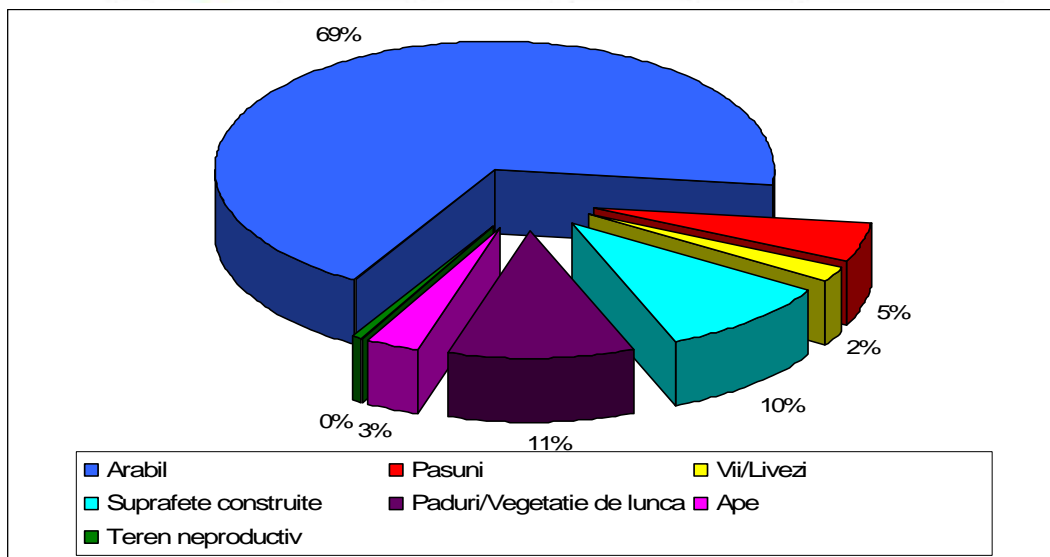
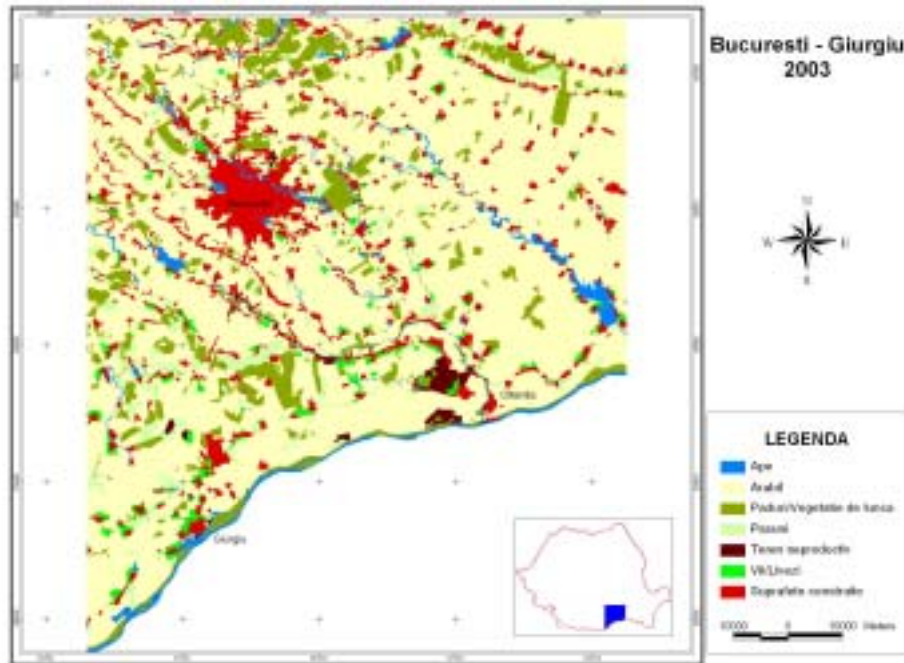


Fig. 4 LCCS Map – Bucharest and Ilfov and Giurgiu counties-2003 (area of interest)

Comparative study showed that the proportions of classes in the period 2000-2003 have changed very little. Thus in the Bucharest area the surfaces of agricultural land was less by two percents, the bare soil was at half and the built up areas, areas with natural vegetation and wetlands were increasing.

In the period 2000 – 2003 in the Danube Delta and lagoons was decrease the proportion of agricultural and wetland and the riverside vegetation was decrease one third.

It's important to mention that the built up area from Danube Delta and lagoons were increasing one half from the 2000-th, the regions with aquatic vegetation were increasing by halve and the grassland was increasing by 1/5 from 2000.

In the period 2000 – 2003 there are not recorded important changes in the area Banat; the proportion of agricultural land was decrease by 1% and the surfaces of grassland was increase with the same percent.

Analysis of LCCS/LU maps from 2000 and 2003 showed the changes of proportion of LC classes in the 3 areas from Romania (Danube Delta and lagoons, Area of Bucharest and Giurgiu and Ilfov county, Banat county). The important changes in these regions are the decrease of agricultural lands, the increase of built up areas and grassland and the surfaces of areas of natural aquatic vegetation from Danube Delta and lagoons. All these changes involve the appearance of same places of environment for development and the maintenance of the populations of mosquitoes, vectors for West Nile virus that impose modern methods for monitoring and control at regional and national level of the mosquito populations.

3. Conclusions

To establish a control strategy we will develop the areas of interest:

- Moldavia – region of Iasi and S of Moldavia;
- Transylvanian Plateau ;
- S, SW and W of Romania (especially along the river Danube to Danube Delta).

For historical interest we will make studies from the years:

- 1935 - data about the presences of mosquitoes in the area of Comana Lake-Giurgiu County;
- 1955 - area of Targu Mures – in July – August were abundant precipitations and were register 16 persons with neurological infections;
- 1962 - area of Roman and Iasi (in that period in South of France-region of Camargue was an outbreak of WNV) and assume that will be a link by Romanian cases;
- 1964 - were cases of infection of WNV in the region of Banat (Oravita);
- 1985 - were strong floods in the region of Comana Lake – Giurgiu County and appeared infections by WNV;
- 1986 - changes in land cover/land use in the region of Comana Lake – Giurgiu County and were intercalate the flood (from 1985) by drain surfaces (from drainage of 1986)-the better environment for mosquitoes;
- 1990 - the strong changes of land cover/land use in the rural region by the division of the agricultural lands and the appearance of gardens (vegetables and flowers with large amount of water-better for vectors-mosquitoes) and the places for breeding domestic animals and birds (principal and secondary hosts – birds and horses) – appearance inside of locality of a focal point of infection;
- 2005 - the floods from the region of Banat;
- 2006 – the floods from the Valley of Trotus and Siret rivers.

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