

# Light pollution and Dark-sky parks

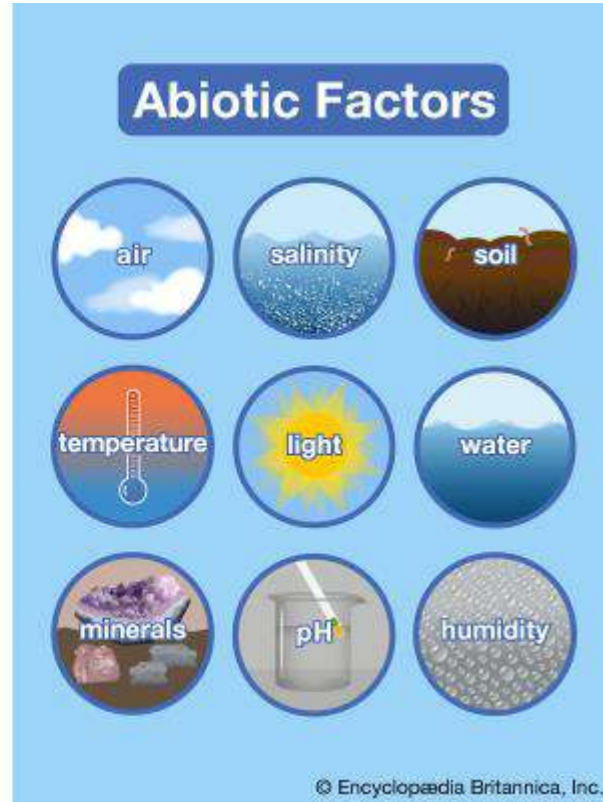
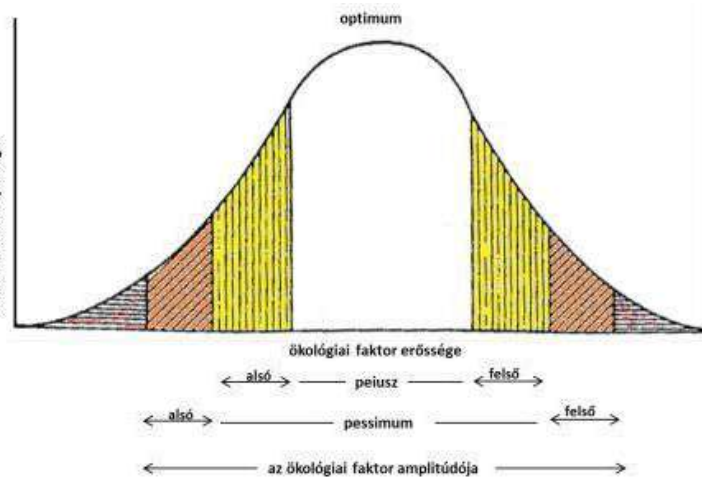
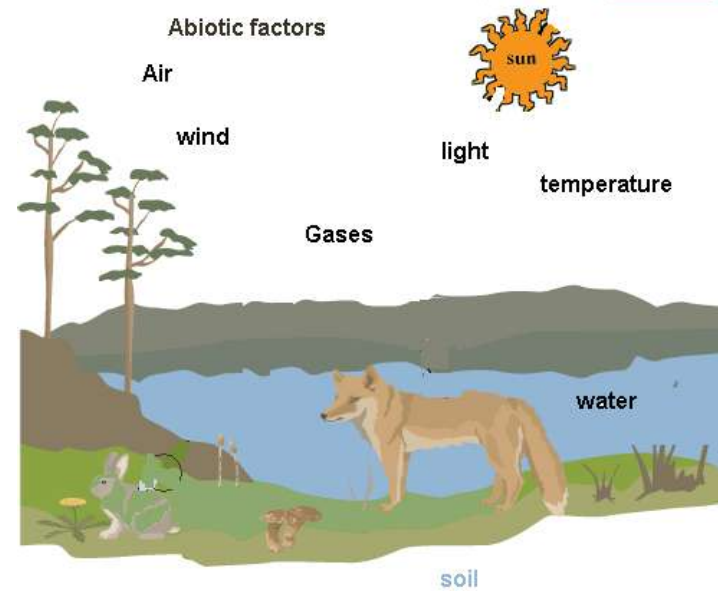


INSPIRATION SESSIONS  
Friday, 6 October 2022

István Gyarmathy  
Hortobágy National Park, Hungary

# Light is an important abiotic environmental factor in ecosystems

- Light plays an important role in the life, behaviour and interactions of individuals and their populations, and thus in the functioning of the whole ecosystem.
- Its absence is as much a problem as its excessive intensity, inadequate spatial and temporal distribution or spectral pattern.



Van Gogh:  
Café terrace at night (1888)





© DW/Spiegel TV





# *Turtles in danger!*

(*Caretta caretta*, *Chelonia mydas*,  
*Dermochelys coriacea*)

- Babies hatch from eggs and head towards the lights instead of the sea.
- Even the laying of eggs can be delayed by the lights.
- Predation is increasing.
- **Excess light can lead to species extinction!**



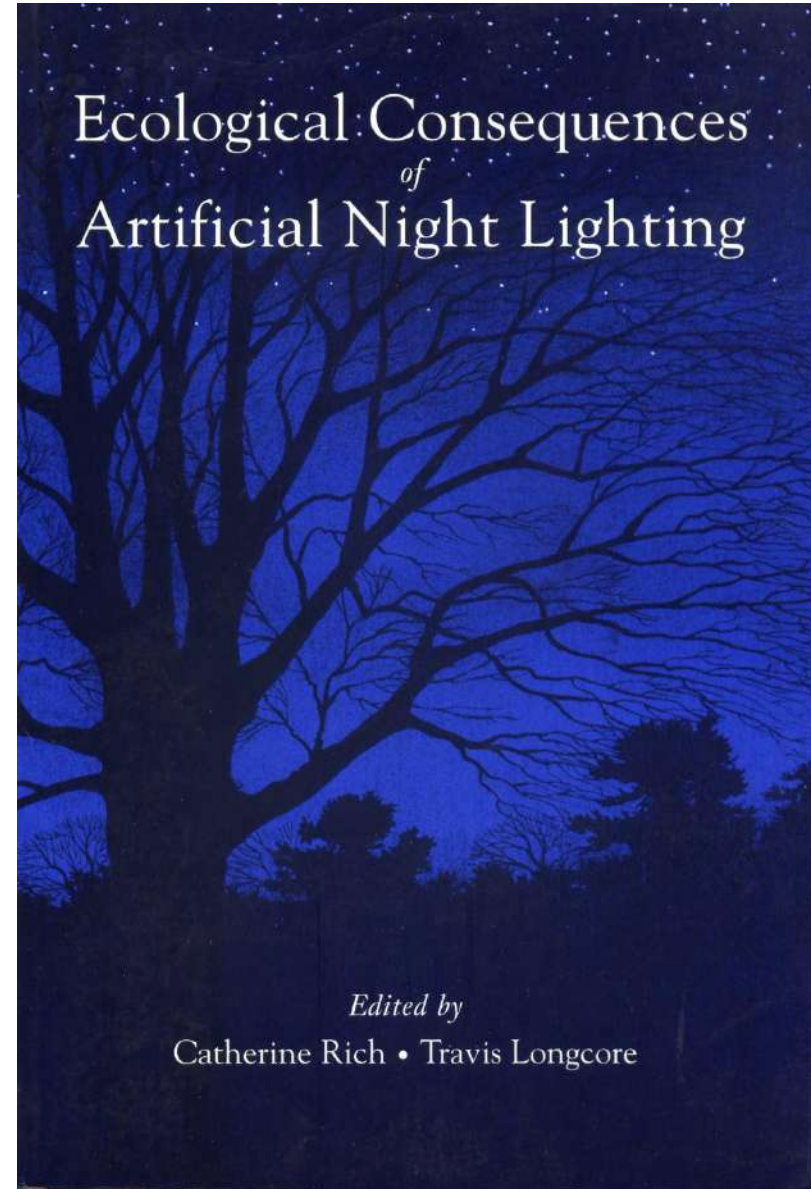


- The negative impact of light pollution on wildlife is nowadays confirmed by a large number of research.
- The number of such studies has increased significantly in recent years:

[scholar.google.com](https://scholar.google.com)

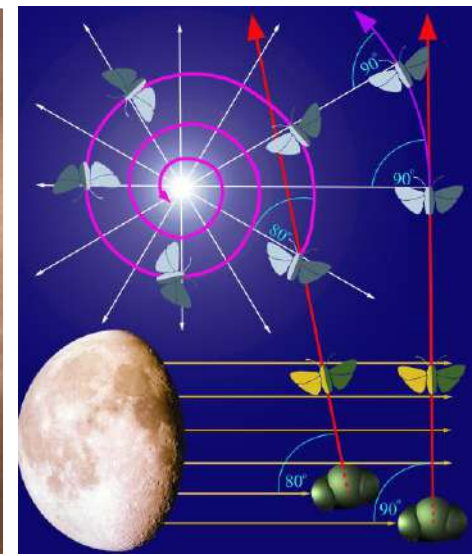
**„ecological effects of light pollution“:**

- 2005: 27.000 hits on the web
- 2010: 33.500
- 2014: 49.500
- 2023: 2.200.000**



# Negative impacts of light on wildlife

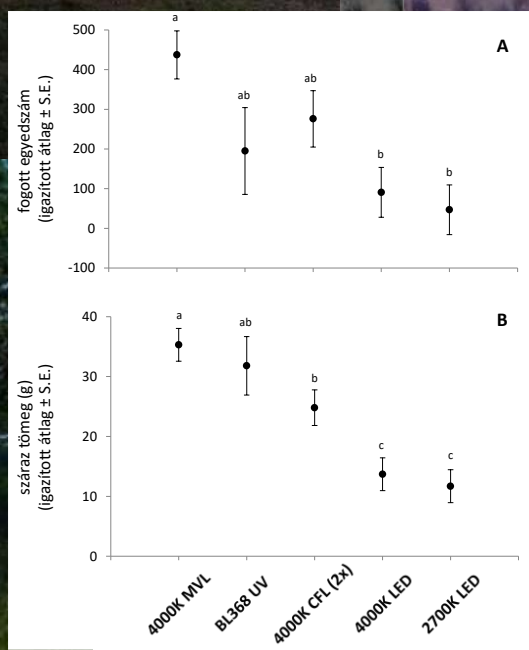
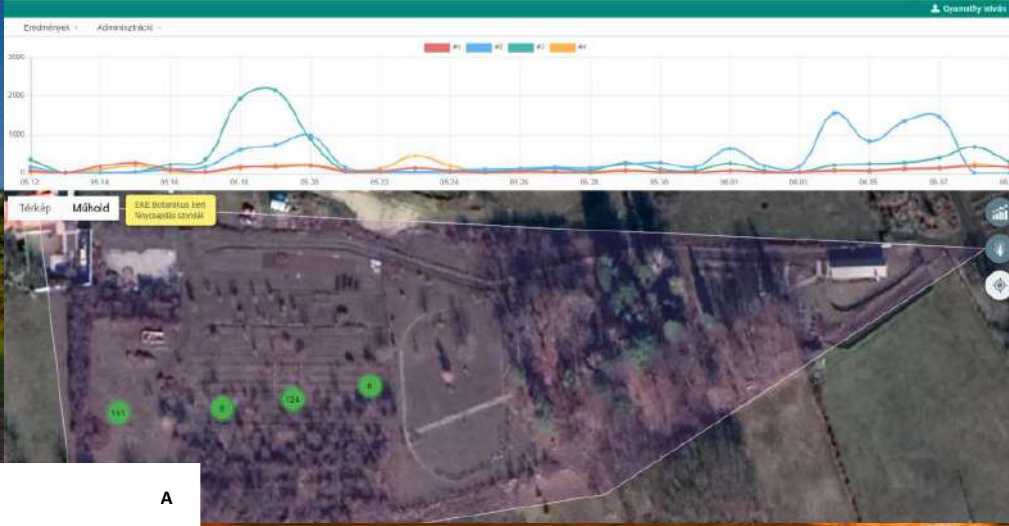
- Changes in the natural rhythm of day and night, the duration of illumination – diurnal and annual rhythm
- Endocrine system, circadian rhythm!
- Attraction or repulsion from habitat
- Disruption of the food chain, - less time to feed
- Collision, diversion
- Habitat fragmentation
- Increased exposure to predators
- Disruption of orientation and migration
- Blinding (10-40 minutes!)
- Separation of breeding partners, disrupting reproduction, brood rearing.
- Disrupt communication.
- Changes competitive relationships.
- Disruption of the ecosystem (material-energy-information flow and patterns), ecosystem services.



During a study in Debrecen, 17,400 individuals of 148 species of ground beetles was caught, during 50 collections along an illuminated wall surface.



# INSECT ATTRACTING EFFECT OF LIGHT SOURCES WITH DIFFERENT COLOUR TEMPERATURES



In Hungary the 1,300,000 street lighting fixtures remove around 400 tonnes of insects from habitats every year!

# Landscape and lights



- Light pollution is alien to the natural landscape - both the individual distracting lights and the light pollution of settlements.

- Freedom from light pollution is synonymous with an undisturbed, natural environment and landscape.



# An important task of protected areas is to preserve an undisturbed nighttime environment!

**La Palma Declaration (2007)**  
**„Starlight initiative”**

**IUCN World Conservation Congress (2012)**  
**Dark skies and nature conservation**



**GLOBAL ASSESSMENT OF  
LIGHT POLLUTION  
IMPACT ON PROTECTED AREAS**

CIESIN Center for International Earth Science Information Network  
The Earth Institute at Columbia University  
AIT Austrian Institute of Technology

**Christoph Aubrecht - Malanding Jaiteh - Alexander de Sherbinin**

**WORKING PAPER**  
January 2010

The bottom of the cover features a row of logos for the organizations involved: CIESIN (Columbia University), AIT (Austrian Institute of Technology), IUCN, WCOPA (World Commission on Protected Areas), Cities (World Commission on Protected Areas and Protected Areas Specialist Group), and DSAG (Dark Skies Advisory Group).



## Biodiversity plan and landscape strategy - Hungary

- To ensure effective and coordinated action to protect against light pollution
- The integration of the concept of light pollution reduction into legal legislation (e.g. nature conservation management plans).
- New starry sky sites.
- Preserve and improve the visibility of the starry sky, free from light pollution.
- Reducing the impact of light pollution on wildlife.

## Biodiversity strategy - Germany

- Stop increase of artificial light till 2030.
- 10% of surface secured for natural darkness.



## International and national programs and initiatives to protect dark-sky

- IDA – dark sky parks, reserves, communities
- UNESCO – Starlight reserves Astronomy and world heritage
- US NPS – Night sky program
- Parks Canada – dark sky parks
- Dark sky parks under national legislation (Slovakia, Poland, etc.)
- IUCN – Dark Sky Advisory Group



# International Dark-sky Parks



## *Eligibility*

- Protected public land (with management plan)
- Exceptional night sky quality
- Night time public access

## *Required elements*

- Lightscape Management Plan (LMP)
- Lighting must meet the LMP
  - Fully shielded fixtures, colour temperature below 3000K (2200 recommended)
- Evidence of commitments to dark skies
- Commitment to public education



# Dark-sky parks all over the world



INTERNATIONAL DARK-SKY ASSOCIATION



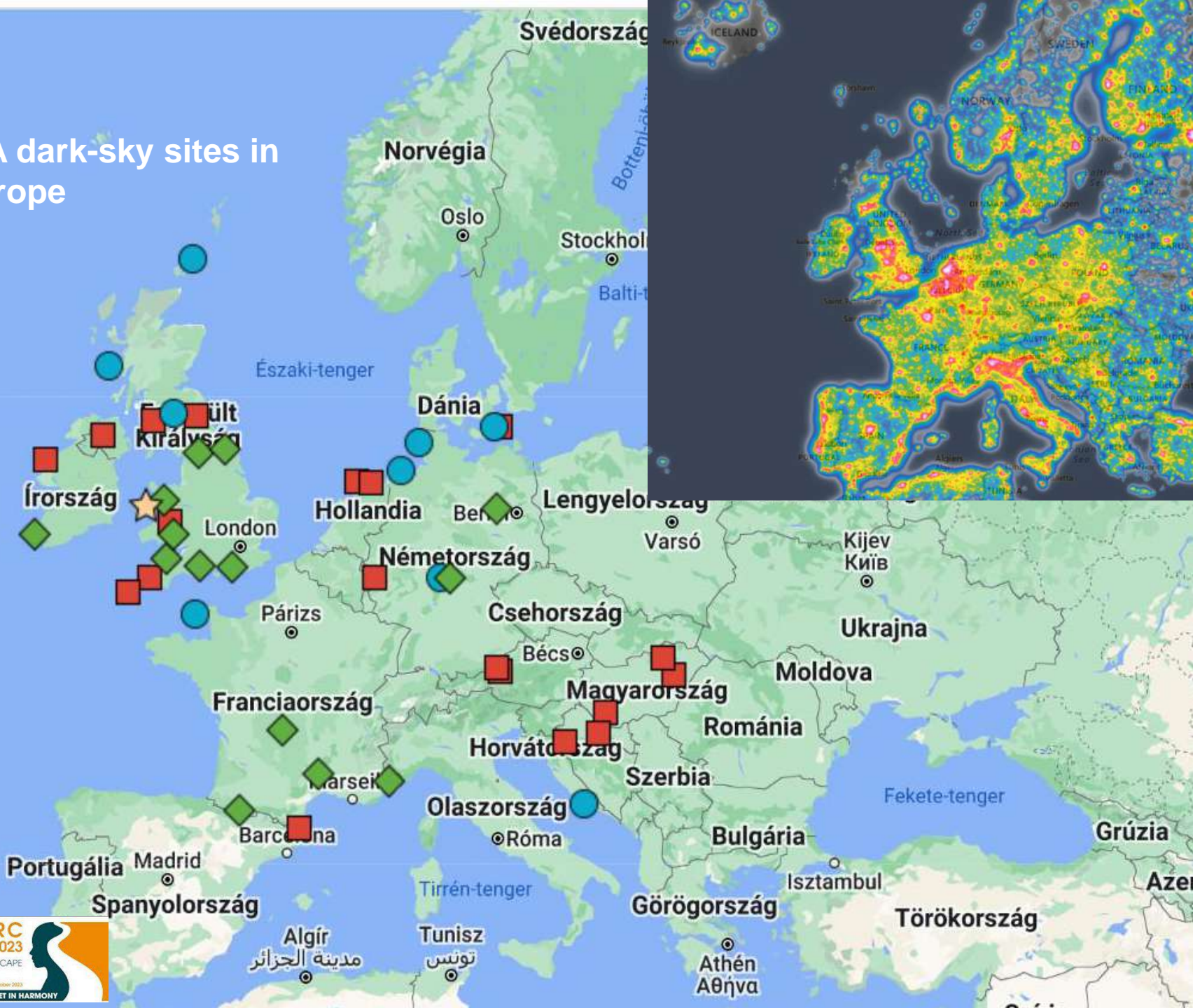
- ★ IDA RESERVES / PARKS
- ★ RASC RESERVES
- ★ STARLIGHT RESERVES
- ★ INDEPENDANT RESERVES

2023: about 300

[www.dsag.darksleeparks.org](http://www.dsag.darksleeparks.org)



# IDA dark-sky sites in Europe





[More Information](#)



**Bükk NP**

**Hortobágy NP**

**Zselic LPD**





Slovakia



★ Budapest

Kecskemét

Hungary

Kecskemét

Miskolc

Hortobágy NP

Tiszafüred

Balmaújváros

Hajdúszoboszló

Debrecen

Püspökladány

Debrecen

Oradea

© 2008 Cnes/Spot Image  
© 2008 Tele Atlas  
Image © 2008 DigitalGlobe  
© 2008 Europa Technologies

Google™

Eye alt 56.80 km



20°43'09.77" E

Streaming ||||| 100%

©2007 Google™

Eye alt 269.37 km

# Hortobágy on the Great Plain – Island of nature and natural darkness



LANDSAT image about Hortobágy area



60 km





**Hortobágy National Park (established in 1973)  
Biosphere Reserve (1979), Ramsar Site (1979),  
World Heritage Site (1999), Natura 2000 site (2004),  
International Dark-sky Park (2011)**

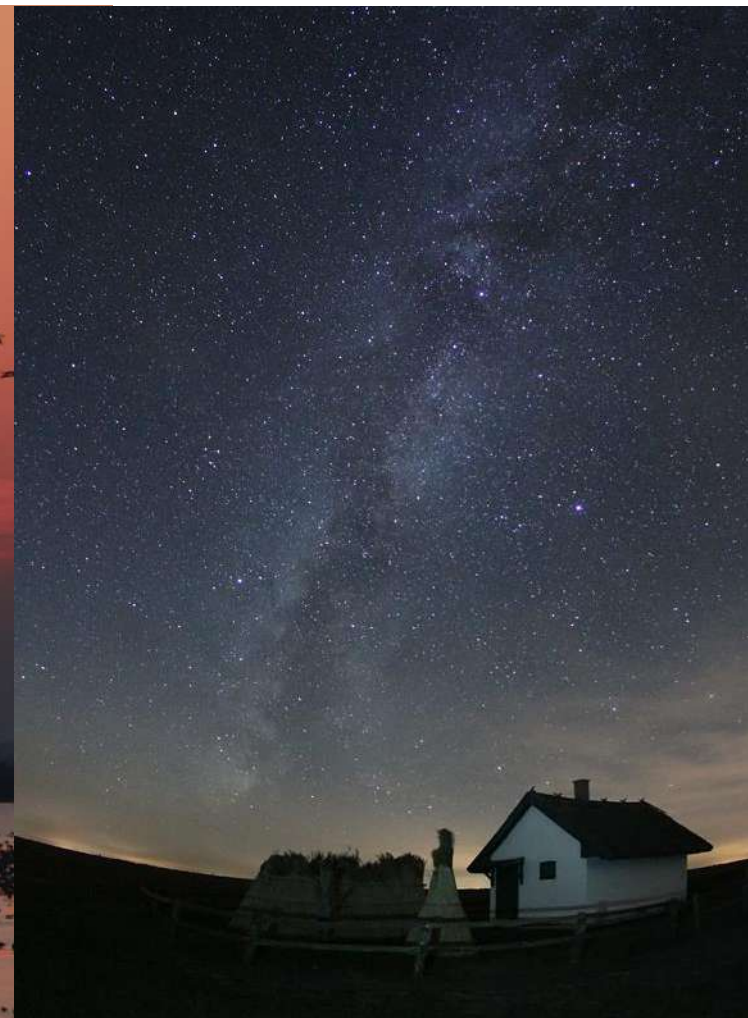
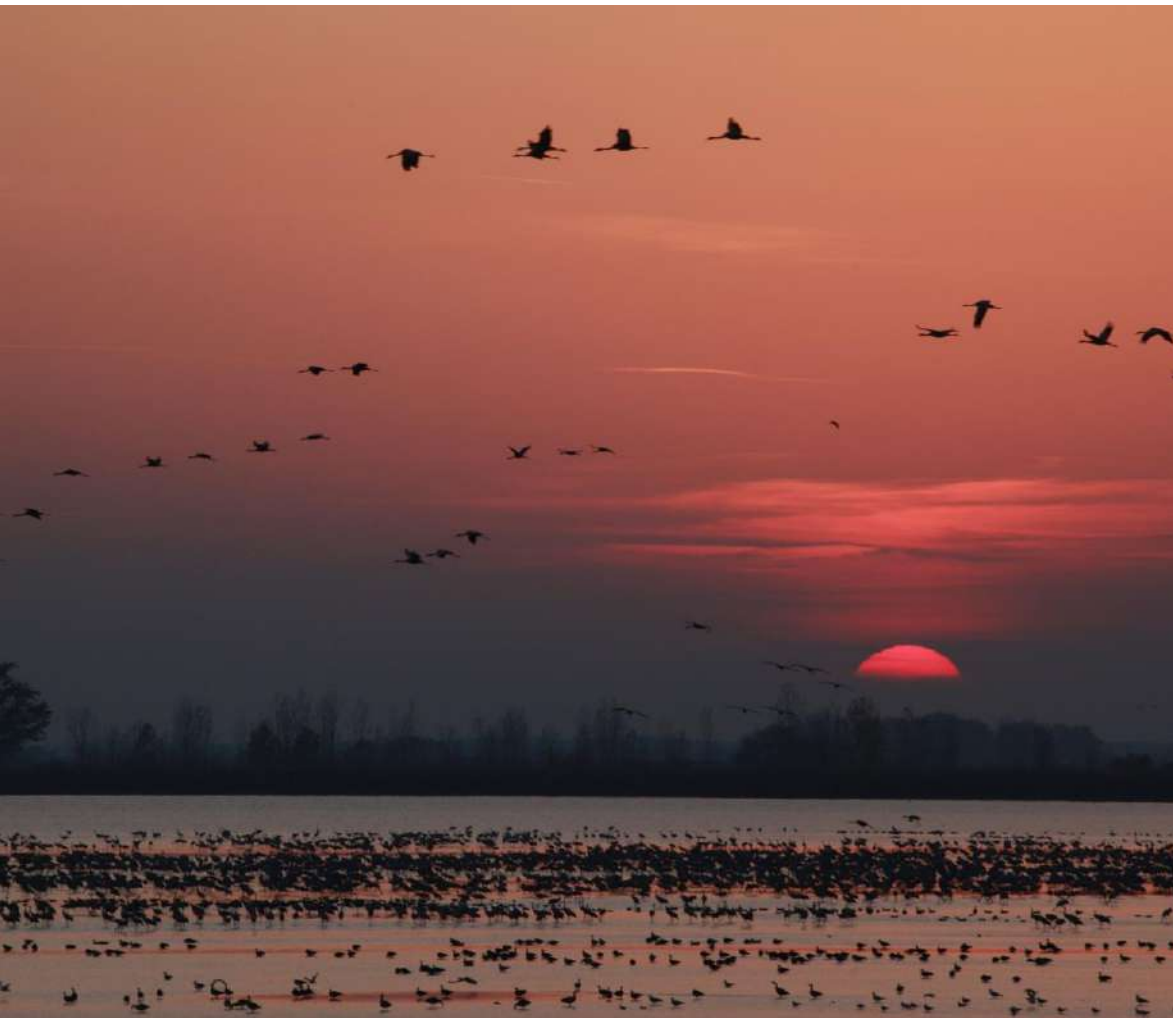


## ”Where the Sky touches the Earth”

- Hortobágy is the biggest unpopulated area in Hungary
- The unbroken horizon of the steppe is unique in Europe
- The short-grass steppe is maintained by traditional grazing



# High biodiversity and „endless steppe”: - wildlife and natural landscape needs lightpollution free environment!



Hortobágy's fauna is extremely rich.

The obtrusive light-free environment is essential for the wildlife as eg. insects at night and migratory birds.

1. sztyepplepke (*Paracossulus thrips*)
2. nagy szikibagoly (*Gortyna borelii lunata*)
3. sziki ürömbagoly (*Saragossa porosa kenderesiensis*)
4. magyar tavaszi-fésűsbagoly (*Dioszeghyana schmidtii*)
5. keleti lápibagoly (*Arytrura musculus*)
6. nagy éjjeli pávaszem (*Saturnia pyri*)
7. kis pávaszem (*Saturnia pavonia*)
8. kéköves bagoly (*Catocala fraxini*)
9. C-betűs aranybagoly (*Lamprotes c-aureum*)
10. barna gyapjasszövő (*Eriogaster lanestris*)



## Main steps of preparation of establishment the starry sky park

- Light pollution measurements and mapping
- Lighting inventory
- Management plan
- Lighting regulation (Lightscape Management Plan)
- Pilot lighting projects
- Awareness programs (website, leaflets, tourist-map, night time walks, astronomical programs, etc.)

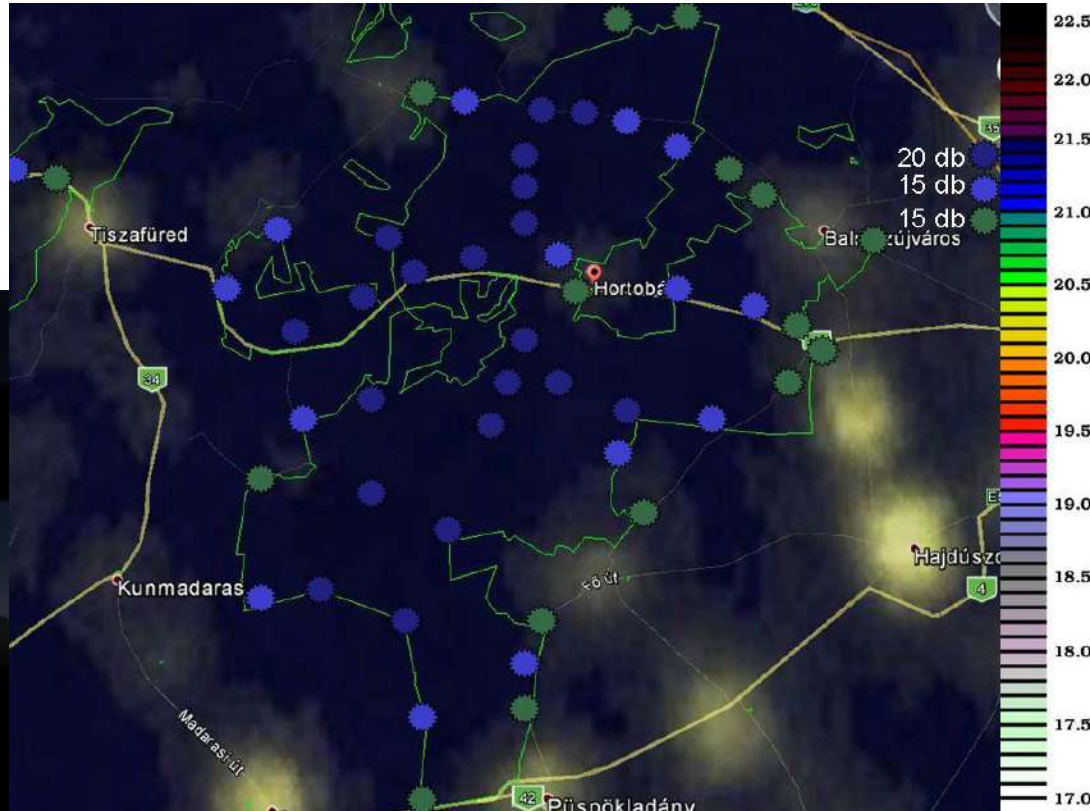
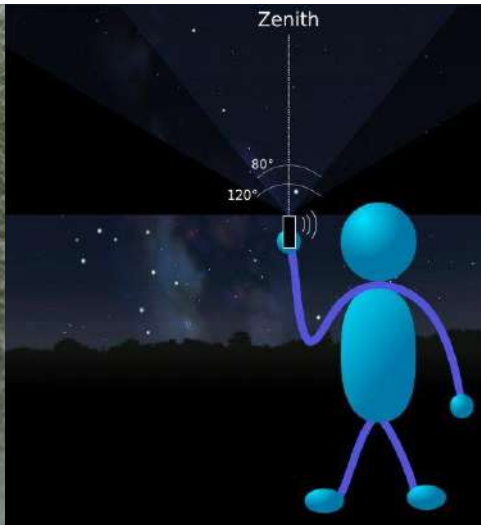




# Monitoring with SQM

Sky brightness measurement with Unihedron Sky Quality Meter (SQM)

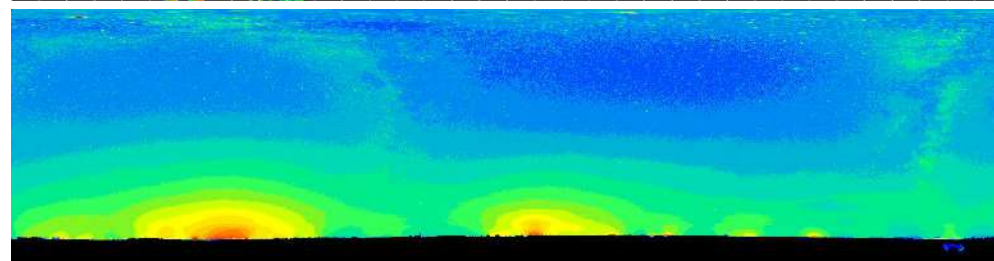
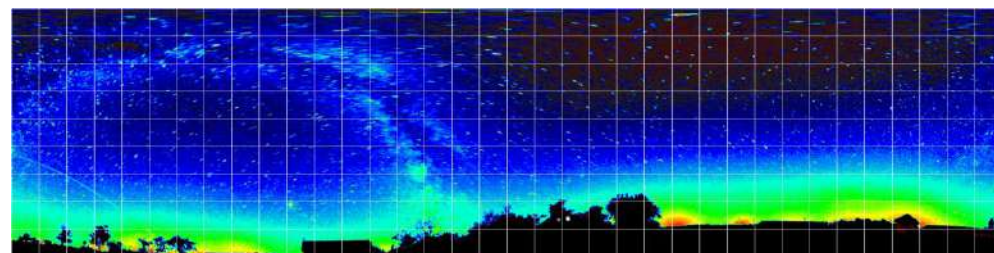
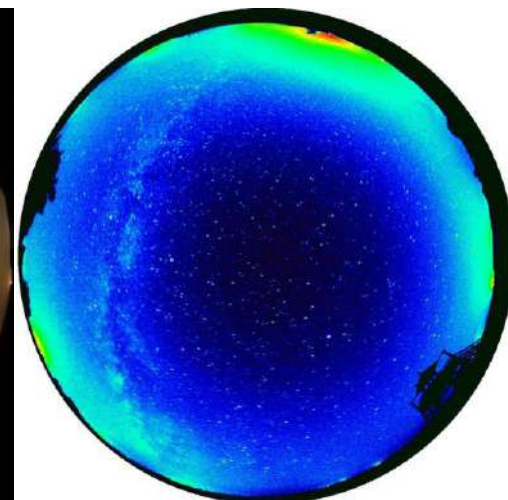
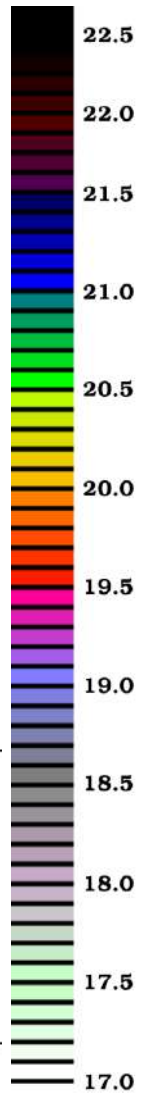
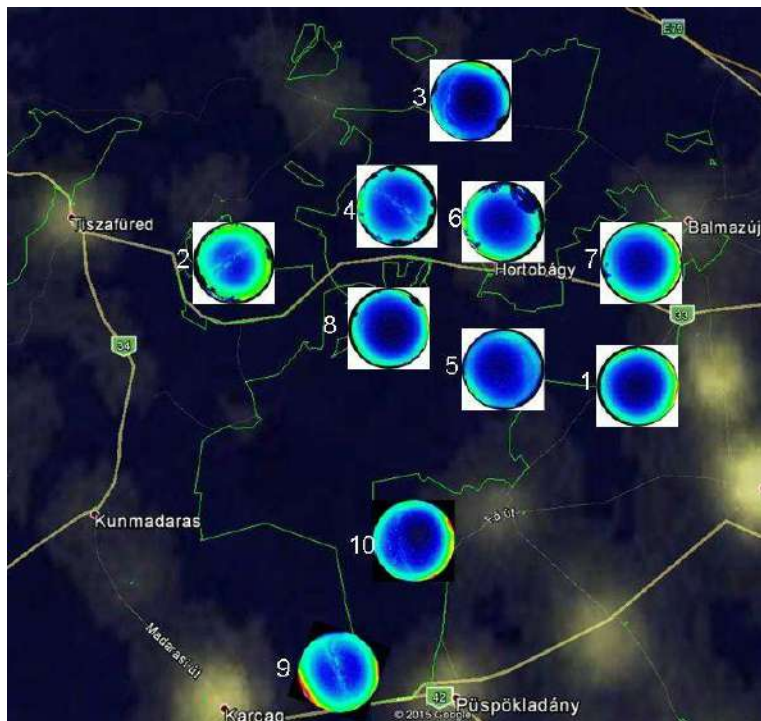
Magnitude /arcsecond<sup>2</sup>



Average SQM value  
21,5  
IDA: Silver tier

# Monitoring with DSLR camera

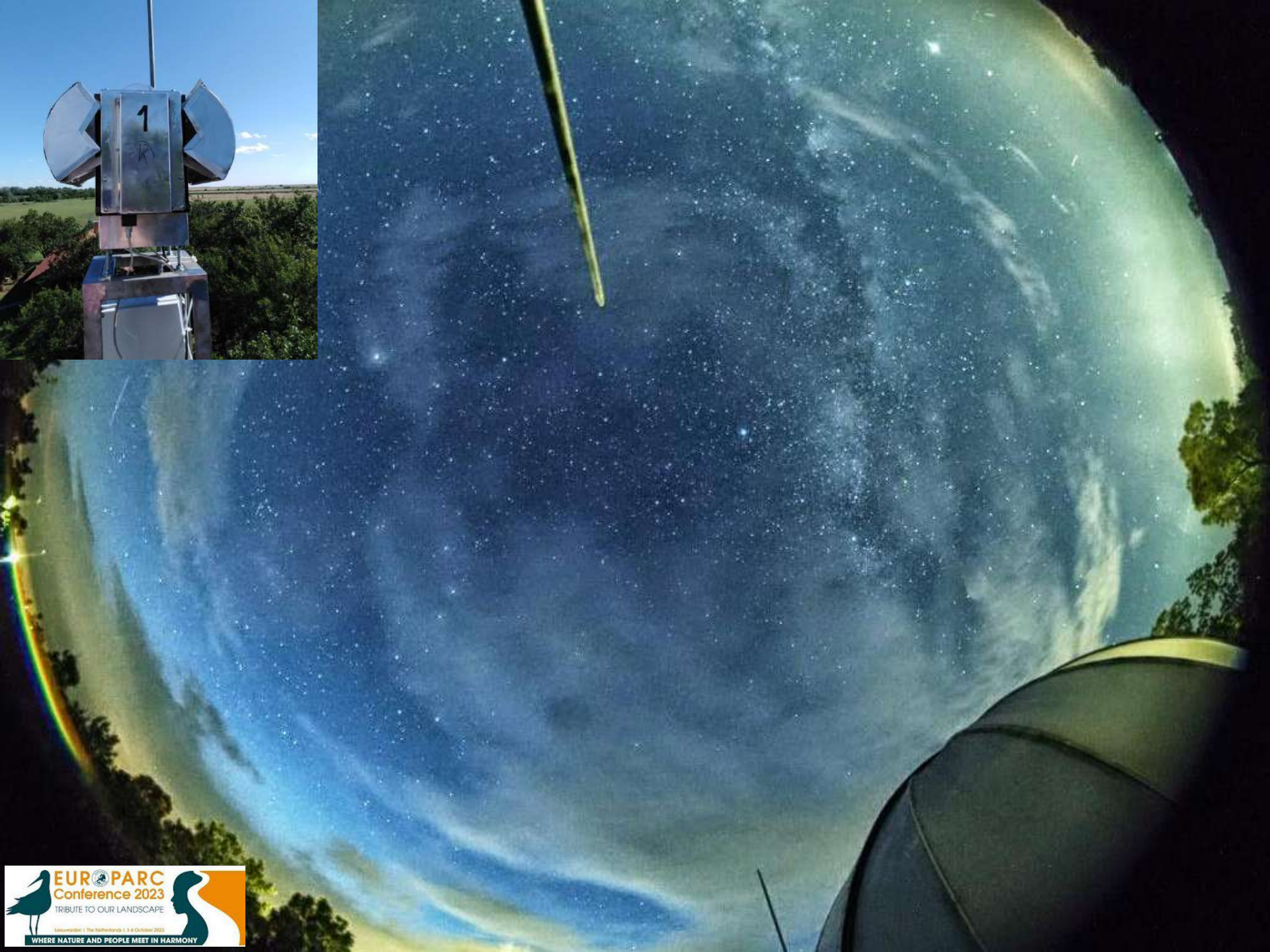
Light-pollution is measured with a calibrated digital camera + fish-eye or wide field lenses  
 - processed with Zoltán Kolláth's DCLUM and DiCaLUM software



	NSU	mag/arcsec <sup>2</sup>
Zenith:	1.24	21.36
SQM-L:	1.18	21.42
SQM:	1.18	21.42
Mean:	1.64	21.06
Min:	0.85	21.77
Max:	11.34	18.96

Horizontal illuminance: 4.33 mlx

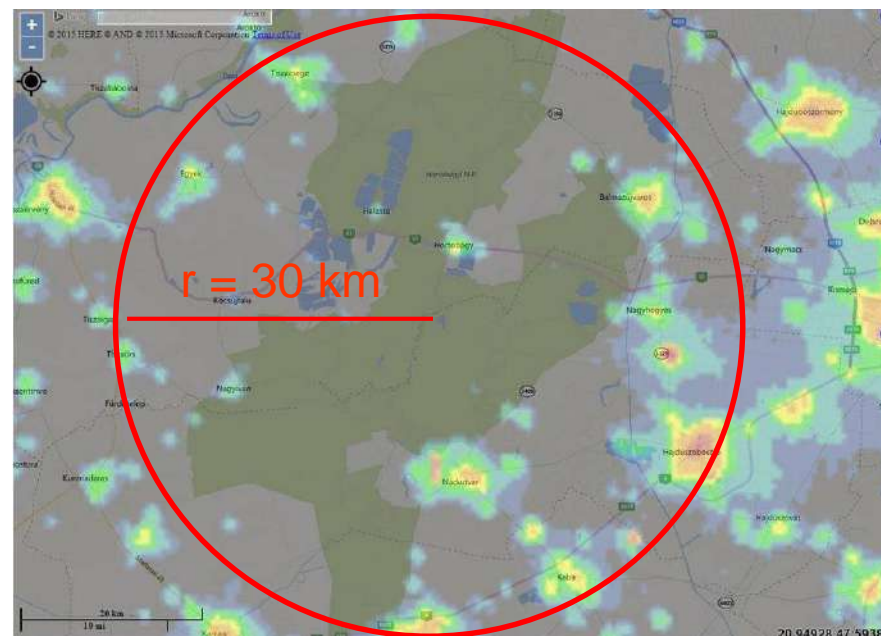
The deterioration of the nocturnal sky for zenith - distances less than 80 degrees - is acceptable.



# Lighting inventory, night patrols



# Disturbing lights on the horizon (lack of natural shade)



Average distance of the surrounding settlements is 20-30 km from the middle of the park - **lighting regulation is vital in the buffer zone of the park!**

## New possibilities for regulation:

- Nature protection law
- National building law
- County spatial plan
- National Park buffer zone
- National Park management plan
- Natura 2000 management plan
- World Heritage management plan

Territorial category	Maximum luminous flux per luminaire (lumen)		Maximum luminous flux on the illuminated surface (lux)	
	before 23 pm	after 23 pm	before 23 pm	after 23 pm
buffer zone, side street	3200	2150	6	4
buffer zone, main street	4300	2150	8	4
buffer zone, highway	6400	3840	10	6
buffer zone, industrial or agricultural site	4300	2150	8	4
World Heritage area, street	3200	2150	6	4
World Heritage area, site	2150	-	4	0
Color temperature	buffer zone: max. 3000 K, World Heritage area: max. 2700 K			
ULR (%)	0			
lighting point height	pedestrian path: 1 m, small roads: 6 m, main roads: 10 m			

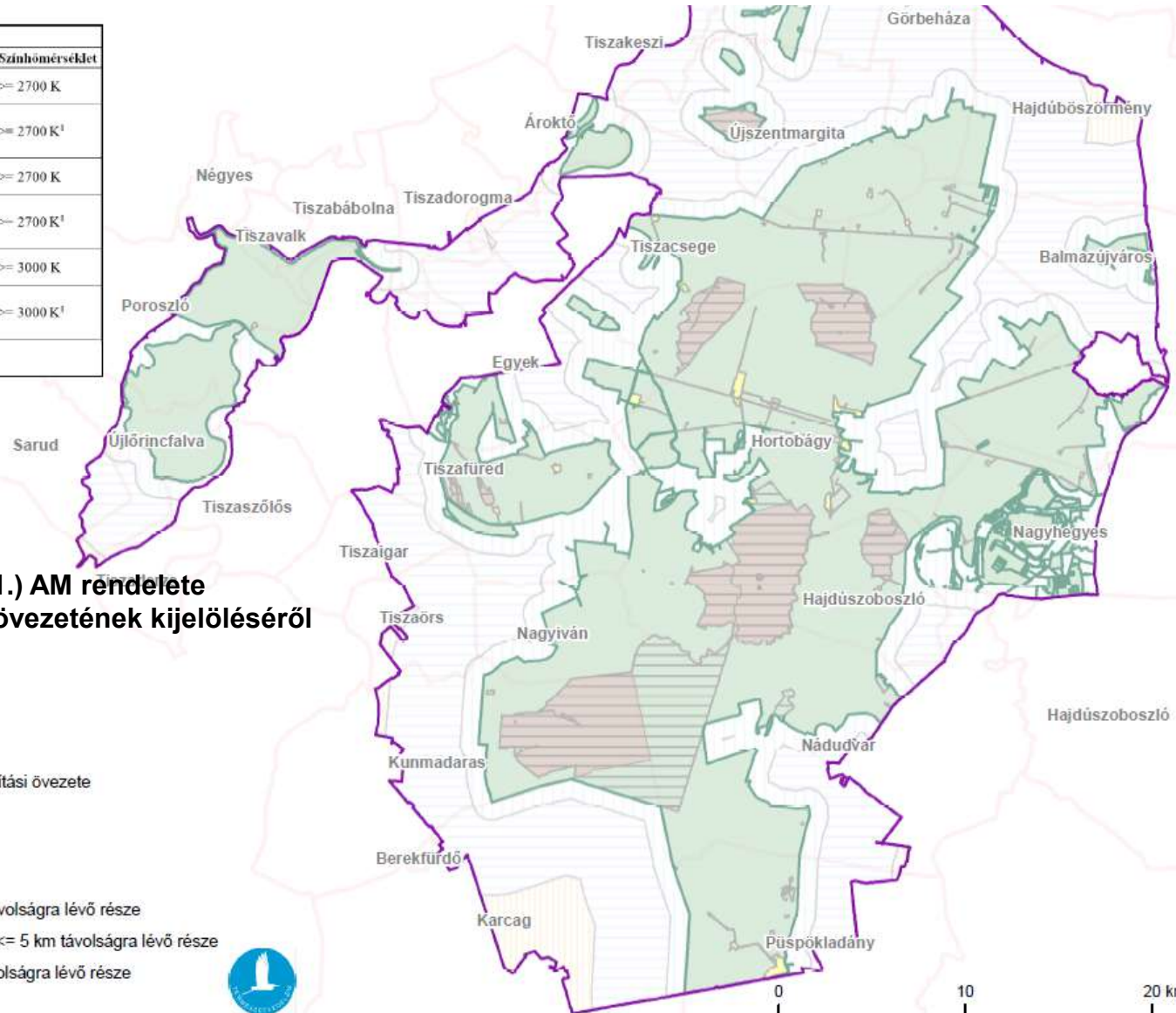
## A Hortobágyi Nemzeti Park és védőövezete

A fényforrásokra és világítótestekre vonatkozó engedély-kötelezettség műszaki paramétereit a védőövezeten belüli differenciálásának feltüntetésével

## Ministerial decree: Buffer zone with lighting regulations

Helyszín paraméter	Műszaki paraméter		
	Fényáram	vagy	Színhőmérséklet
A tevékenység helyének a Hortobágyi Nemzeti Park határától számított legkisebb távolsága $\leq 1$ km	1 db világítóttest vagy fényforrás esetén $\geq 1000$ lumen		$\geq 2700$ K
	Több világítóttest vagy fényforrás esetén az összegzett fényáram $\geq 3000$ lumen		$\geq 2700$ K <sup>1</sup>
A tevékenység helyének a Hortobágyi Nemzeti Park határától számított legkisebb távolsága $\geq 1$ km és $< 5$ km	1 db világítóttest vagy fényforrás esetén $\geq 2000$ lumen		$\geq 2700$ K
	Több világítóttest vagy fényforrás esetén az összegzett fényáram $\geq 6000$ lumen		$\geq 2700$ K <sup>1</sup>
A tevékenység helyének a Hortobágyi Nemzeti Park határától számított legkisebb távolsága $> 5$ km	1 db világítóttest vagy fényforrás esetén $\geq 3000$ lumen		$\geq 3000$ K
	Több világítóttest vagy fényforrás esetén az összegzett fényáram $\geq 9000$ lumen		$\geq 3000$ K <sup>1</sup>

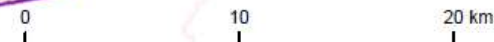
<sup>1</sup> Ha legalább egy fényforrás esetében teljesül a feltétel.



## Az agrárminiszter 45/2020. (IX. 21.) AM rendelete a Hortobágyi Nemzeti Park védőövezetének kijelöléséről

### Jelmagyarázat

- A Hortobágyi Nemzeti Park határa
- A Hortobágyi Nemzeti Park természeti övezete
- A Hortobágyi Nemzeti Park természetkimélő hasznosítási övezete
- A Hortobágyi Nemzeti Park szolgáltató övezete
- A Hortobágyi Nemzeti Park fokozottan védett területe
- A Hortobágyi Nemzeti Park védőövezetének határa
- A védőövezetnek a nemzeti park határától  $\leq 1$  km távolságra lévő része
- A védőövezetnek a nemzeti park határától  $> 1$  km és  $\leq 5$  km távolságra lévő része
- A védőövezetnek a nemzeti park határától  $> 5$  km távolságra lévő része



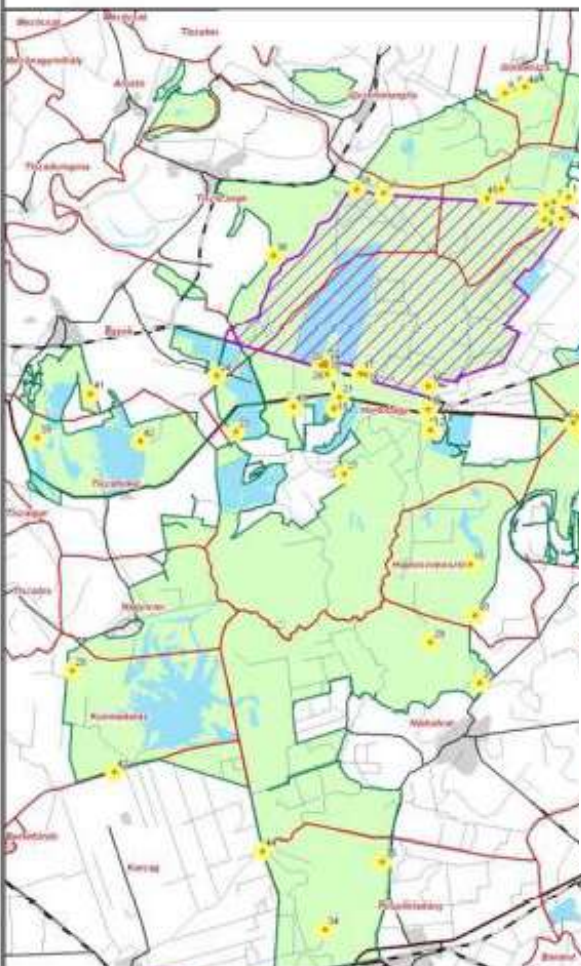
# Dark-sky park zone in the County Spatial Plan

# Night Light

Interreg Europe



HAJDÚ-BIHAR MEGYE TERÜLETRENDEZÉSI TERVE 3/14.  
A csillagos égbolt park övezetének területe



1:180 000

0 5 10 15 km

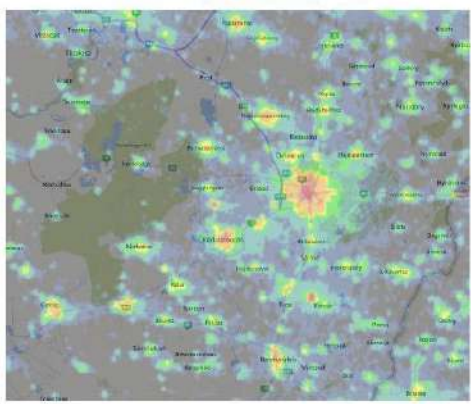
\* Tervezési övezetek: 1. város, 2. természetvédelmi övezet  
 \*\* Csillagos égbolt park övezet, III. övezet



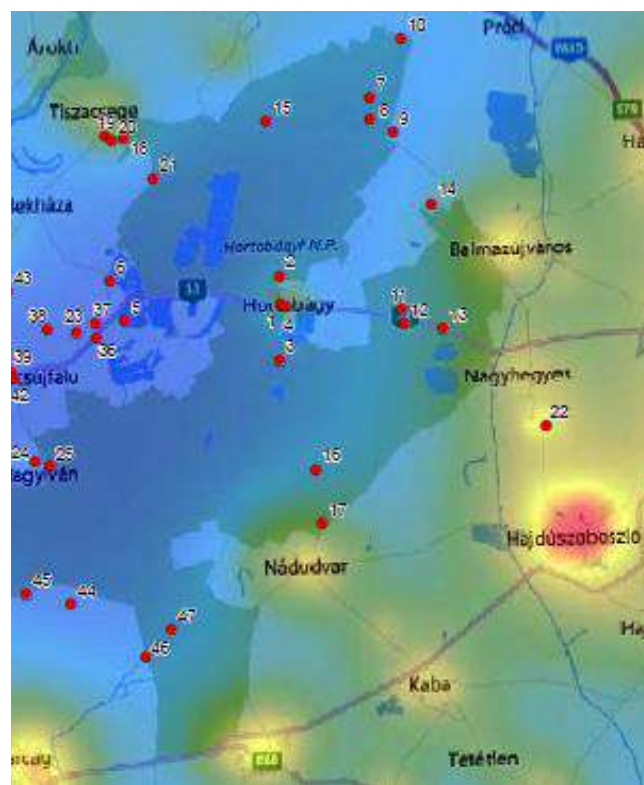
Night Light  
Interreg Europe

Háttéranyag a NIGHTLIGHT  
Hajdú-Bihar Megyei Regionális Akciótervhez

Cyarmathy István természetvédelmi ökológus



Debrecen, 2020.



Sorsz.	Település (városok)	Sorsz.	Település (községek)
1.	Hajdúböszörmény	1.	Egyek
2.	Hajdúszoboszló	2.	Görbeháza
3.	Balmazújváros	3.	Hortobágy
4.	Püspökladány	4.	Nagyhegyes
5.	Nádudvar	5.	Újszentmargita
6.	Tizacsege		



## Main requirements:

- motion detector (if possible no permanent lights)
- up to 2700 Kelvin color temperature
- maximum 1000 Lumens/lamp
- fully shielded fixtures, flat lampshade (full cut-off, 0 URL)

## Recommendations, pilot projects

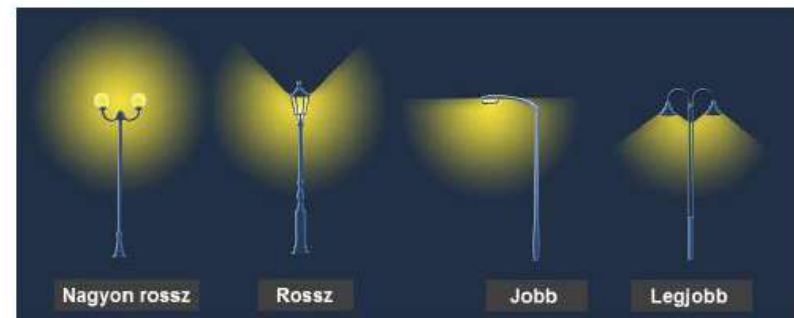
- I. Segédlet a Hortobágyi Nemzeti Park területén és védőzónájában a világítások tervezéséhez és üzemeltetéséhez



1. Színhőmérsékletek: javasolt maximum 2700 Kelvines meleg színhőmérséklet.

LUMEN	250+	450+	800+	1100+	1600+
Hagyományos izzó	25W	40W	60W	75W	100W
Halogén izzó	18W	28W	42W	53W	70W
Kompakt fénycső	6W	9W	12W	15W	20W
LED	4W	6W	10W	12W	18W

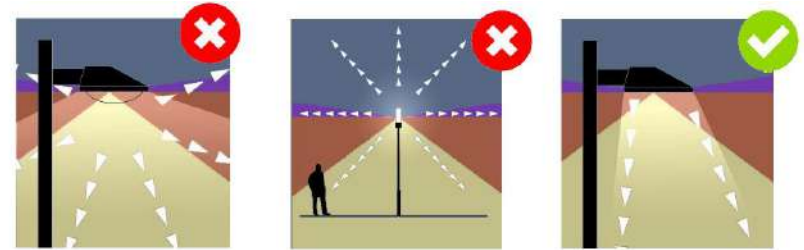
2. Fényáram: javasolt maximum 1000 Lumen (kivélet közvilágítási lámpatestek, itt 23 óráig 1600 Lumen elfogadható), járdavilágítás és irányfény esetében maximum 500 Lumen.



3. Példák a jó és rossz megvilágításra (a világítótestek geometriája, búrája és ernyőzése szempontjából).



# Guide for nature conservation authorities and national park directorates to support decision-making on applications for permits for the installation or replacement of outdoor luminaires or light sources (2020)



**„GUTES LICHT“  
IM AUSSENRAUM**  
Grundsätze für einen bewußteren  
Umgang mit Licht



# The undisturbed night environment is a tourist attraction!



Hortobágyi Csillagoségbolt-park

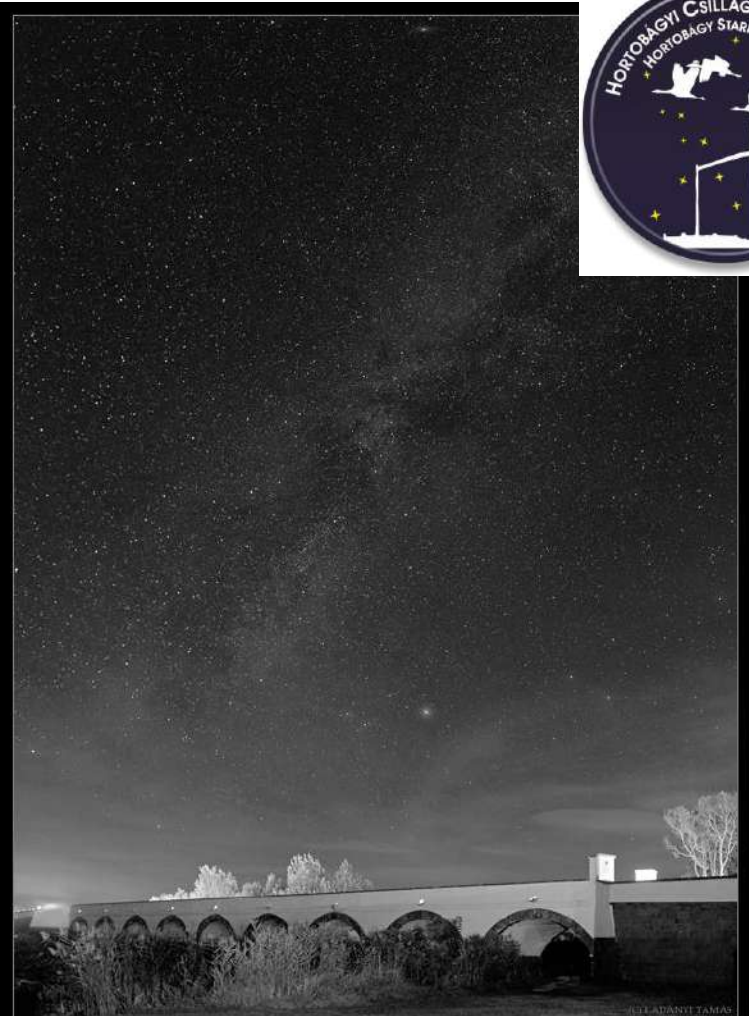
# Ahol az égbolt is élmény

„Where even the sky is an experience”



Hortobágy has many different eco-touristical attractions, starry sky is one of them.

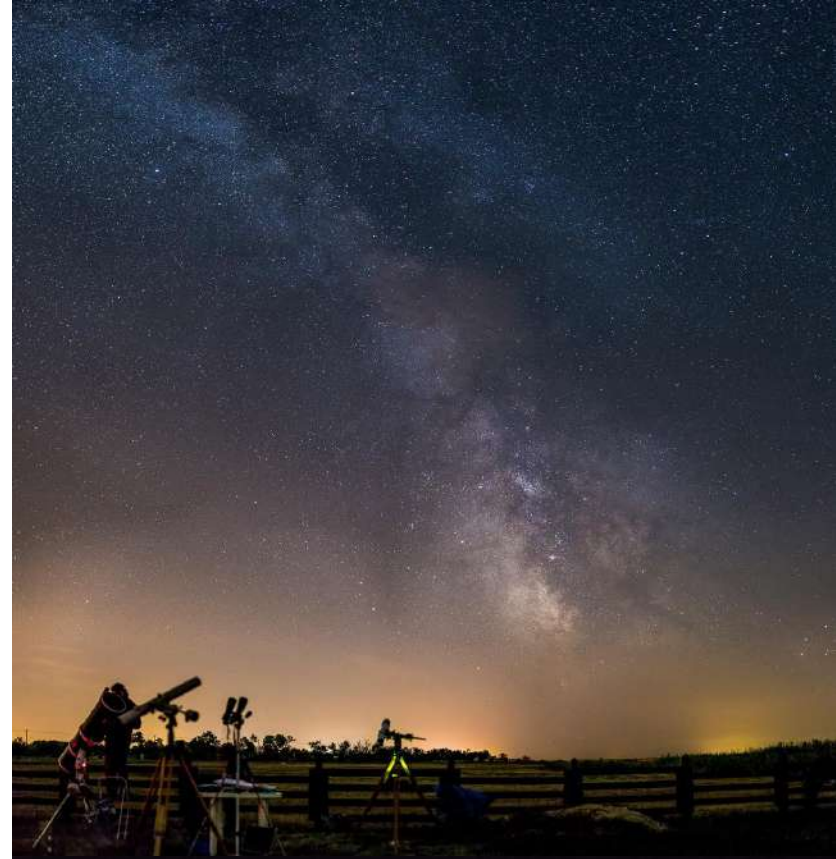
Dark-sky park values are integrated to the different programmes (e.g. bird observations combined with "star-walk", etc.)



# Astro-tourism in Hortobágy

## - a tool for environmental education too

- Evening bird-observation combined with a "starwalk" at the fish-ponds and the wildlife park
  - Guided evening tours, phototours
  - Presentations with stargazing
  - Observatory programs
  - Programs for school groups
  - Recommended places for individual visitors
- 
- **Planned:**
  - **Night-time trail**
  - **Planetarium and exhibition**



# Hortobágy Observatory



## Standard „astro-environmental” education program:

- Slide show: basic astronomical knowledge, light pollution, - its effects on wildlife and landscape, ethnography, stargazing parks
- Under the sky: constellations, myths, orientation
- With telescope: most interesting celestial objects (Moon, planets, double stars, bright deep-sky objects)

We have public nights and stargazing events too.

## Ecotourism and environmental education in Hortobágy Starry-sky Park

- Hortobágy's new ecotourism attraction is the undisturbed nightlife and starry sky!
- Over the last 10 years, approx. 300 different programs have attracted thousands of people.
- The Hortobágy Starry-sky Park has been becoming more and more well known and popular.
- The Starry-sky Park's programs have become an integral part of Hortobágy National Park's ecotourism and environmental education activities (eg. bird watching combined with star walks, forest school programs, excursions, camps, etc.)
- A new message for environmental education: *For protecting wildlife and the natural landscape the light pollution free environment is essential.*
- **Dark-sky parks play an important role in nature conservation and environmental education!**



## Shepherds and the starry sky

Beside preserving the natural values, it is also important to protect the starry sky for the traditional shepherd culture! The knowledge of stars is part of this.

Shepherd culture was an important part for the World Heritage Nomination.

„The shepherds knew the hours from the procession of stars. The Big Dipper, the Pleiades, the Sirius and the Milky Way all turn and indicate where we are in the night.” (local ethnographic collection)

**Hortobágy became part of the UNESCO - IAU Astronomy and World Heritage programme**





**B. NAGY JÁNOS**  
JUHÁSZ  
HAJDÚSZOBOSZLÓ

2019. JANUÁR 29.

ŐSEINK ÉS A CSILLAGOS ÉG  
GYARMATHY ISTVÁN  
KARÁCSONY SÁNDOR  
PÁSZTORCSILLAG CÍMŰ FILMJE



**VARGA SÁNDOR**  
JUHÁSZ  
NÁDUDVAR

2020. FEBRUÁR 19.

ŐSEINK ÉS A CSILLAGOS ÉG  
GYARMATHY ISTVÁN  
KARÁCSONY SÁNDOR  
PÁSZTORCSILLAG CÍMŰ FILMJE



2020. FEBRUÁR 19.

ŐSEINK ÉS A CSILLAGOS ÉG  
GYARMATHY ISTVÁN  
KARÁCSONY SÁNDOR  
PÁSZTORCSILLAG CÍMŰ FILMJE



**TÓTH GYULA**  
JUHÁSZ  
HAJDÚSZOBOSZLÓ

2019. JANUÁR 29.

ŐSEINK ÉS A CSILLAGOS ÉG  
GYARMATHY ISTVÁN  
KARÁCSONY SÁNDOR  
PÁSZTORCSILLAG CÍMŰ FILMJE



## Timing

- You have to get up to milk (on a summer night) when the pole of Göncöl is already down. We were always able to determine the time of the clock from the movement of the Sun. If you had to drive out early the cattle team, we knew from the course of the Sun. We watched the clock from the shadow.
- We stood with our backs to the Sun and learned about the position of the shadow by observing our shadow.

## Orientation

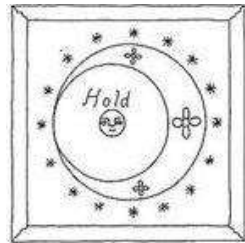
The Sun does not always rise and set in the same place, but in autumn it's already far away.

## Weather prediction

- When the tail of the Moon is up, they say it is not a rainy month. When it is down, it rains.
- If the Moon has a court, it will rain showers. And if there is Saint David, -You knows Saint David-, plays the violin in it. It's going to be windy weather, because Saint David plays the violin.

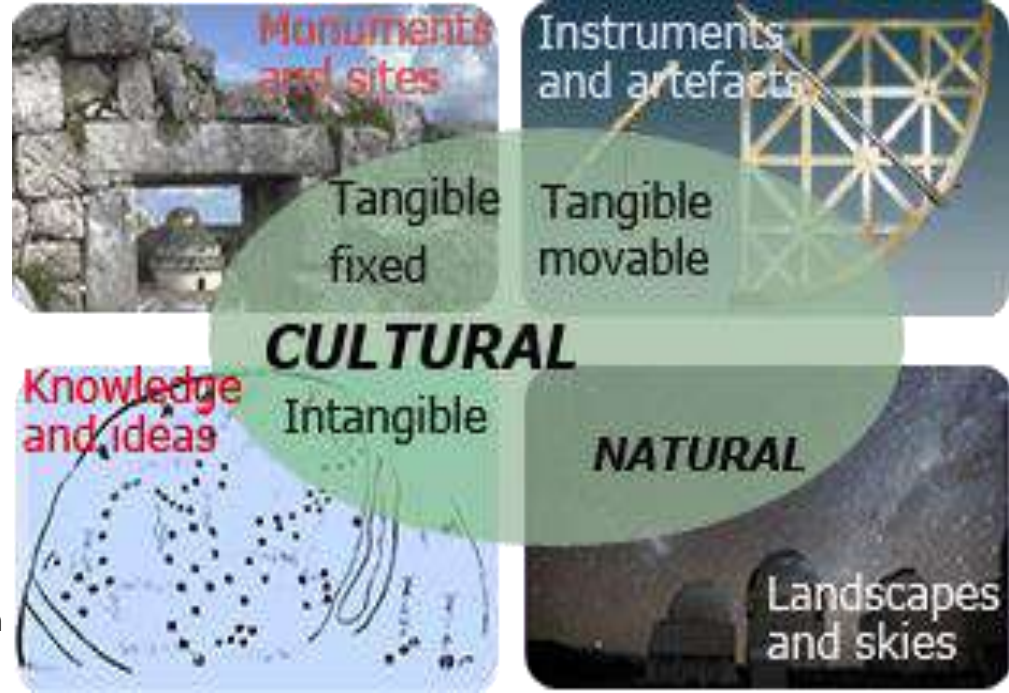
## Beliefs

- Kata also limps (*scintillates*) because the scythe cut off her leg.
- Lame Kati was always jumping. We always said when we were kids: "Sánta Kati, Fiastyúk, outside is the cart, inside is the pole."
- I saw a shooting star (*meteor*). I don't know which fell where. They say it falls more when the bird is molting. They say that there will be many deaths that year.



# Astronomy and world heritage

- Stonehenge World Heritage Property, United Kingdom
- The Astronomical Rock Panels in the Lascaux Cave, France
- Dengfeng observatory, China
- The Jantar Mantar at Jaipur, India
- The Temple of Amun at Karnak, Egypt
- The pyramids of Giza and related buildings, Egypt
- Napata, Sudan (including Djebel Barkal and Nuri)
- The Pantheon, Rome, Italy
- Ulugh Beg's observatory, Uzbekistan
- Strasbourg Cathedral, France, and astronomical time
- Royal Observatory, Greenwich, United Kingdom
- The Struve geodetic arc (multiple locations in ten countries)
- Chankillo, Peru
- Risco Caído and the Sacred Mountains of Gran Canaria, Spain
- Astronomical timing of Irrigation in Oman, Oman





# Portal to the Heritage of Astronomy



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Category of Astronomical Heritage: **cultural-natural mixed**  
Hortobágy Puszta and astronomy in shepherding practices

Description

Map

Gallery

Documents

Format: Short Description (ICOMOS-IAU Case Study format)

Presentation

Geographical position

*Country:* Hungary

*Hungarian name of the World Heritage Area:* Hortobágy Nemzeti Park—a Puszta

*English name of the World Heritage Area:* Hortobágy National Park—the Pusta



The Hortobágy Puszta is a plain located in the Middle-Tisza region and forms part of the Great Hungarian Plain. Administratively, most of its territory falls within the Hortobágy and Nagyunság

Theme

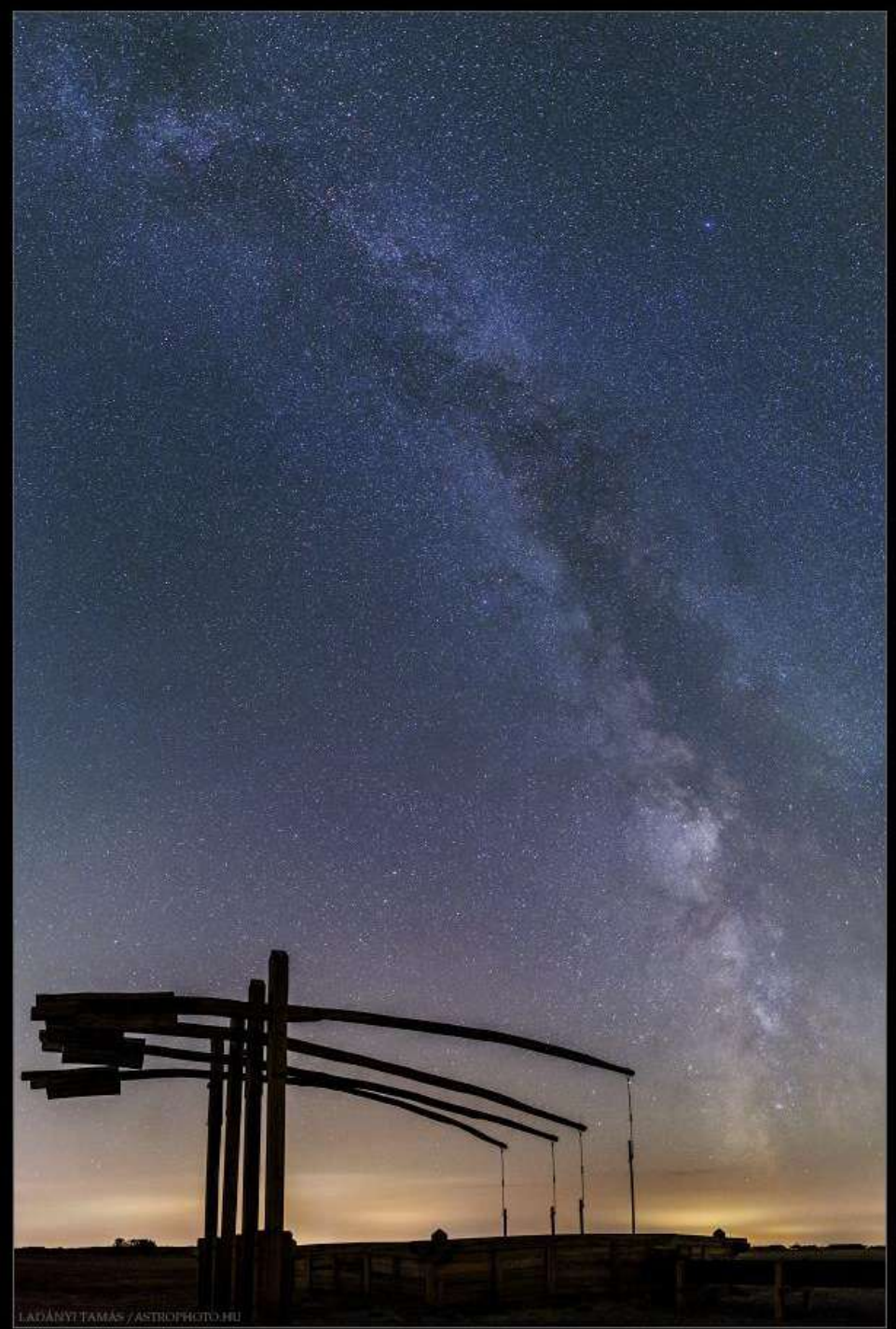
Indigenous uses of Astronomy



Case Study Navigation

- Short Description (ICOMOS-IAU Case Study format)
- Hortobágy Puszta and astronomy in shepherding practices

Thank you  
for your attention!



LADÁNYI TAMÁS / ASTROPHOTO.HU

## **Some points for discussion:**

- Why it is important for conservationists to protect undisturbed nighttime environment?
- What are the benefits of preventing light pollution in protected areas for landscape, wildlife and people (health, education, tourism, etc.)
- How can we promote reducing light pollution (legislation, regulation, stakeholders, interpretation, etc.)
- How can more parks proclaim themselves as one of the dark sky places network? And what is the value of these certificates?

## **Input for statement:**

- The progressive degradation of the night sky must be considered an imminent risk on biodiversity and natural landscapes.
- Sites included in the European network of protected areas which combine exceptional landscape and natural values relying on the quality of their night sky, are called to include the protection of unpolluted night skies as a key factor strengthening their mission in conserving nature. Protected area managers should consider this in their policies and activities.
- Setting up dark-sky parks is a good tool to protect nighttime environment and promote the values of unpolluted night skies. They are important sites of astrotourism which is a new and growing sector of ecotourism.