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# STRATEGIC DEVELOPMENT OF ASTROTURISM IN THE REPUBLIC OF CROATIA – COMPARATIVE ANALYSIS<sup>1</sup>

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### **Abstract**

*The paper investigates the issue of strategic development of a new selective form of tourism that is growing in many countries around the world named astrotourism. The issue of light pollution is also considered, given that a clear starry sky is a fundamental prerequisite for the development of this selective form of tourism. The aim of this paper is to investigate the level of development of astrotourism in the Republic of Croatia. For this purpose, a comparative analysis was performed targeting selected astrotourist destinations - the so-called Dark-Sky Parks in Croatia and Europe, as well as a research focusing on the geographical distribution and number of certified sky parks in the world. Certified Dark-Sky Parks are typical astrotourism destinations that meet all the prerequisites for its development, and are awarded the official certificate issued by the IDA - International Dark-Sky Association, as the world's umbrella institution dealing with light pollution. Observatories have a special role in the development of astrotourism, so the proposed paper presents an overview of observatories in Croatia that are focused on this type of activities. The paper aims to sensitize the scientific and professional public regarding the issue of light pollution, but also to encourage further research and expert discussions relating to this topic. Astrotourism combines different components and functions – a scientific and a recreational one, but also a very important ecological and educational function, encouraging special discussions and proposals focusing on solutions for the sensitive but still insufficiently researched area of light pollution, inadequate public illumination, as well as other “unhealthy” forms of illumination.*

**Keywords:** *astrotourism, light pollution, Dark-Sky Parks*

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## 1. INTRODUCTION

The impacts of mass tourism have been examined in a large number of studies, discussed, and implemented in management practice. This type of tourism produced numerous problems in protected areas and cities that are trying to survive and to organize a better life for their inhabitants. The majority of these locations have decided to transform their strategic documents, plans, activities, and practices to a selective type of tourism based on sustainability. These selective types have a huge potential for attracting and increasing the number of tourists with specific interest. In the context of COVID-19 specific tourism niche will become increasingly popular. In these circumstances astrotourism has a lot of potential for development.

The paper will investigate the issue of astrotourism development in the Republic of Croatia and the world, and the related topic of protection from light pollution. The aim of this paper is to investigate the extent to which astrotourism is developed in Croatia by comparing it to its development in Europe and the rest of the world. The paper particularly focuses on the so-called Dark-Sky Parks as one of the forms of certified tourist destinations for the development of astrotourism. Furthermore, a geographical distribution of Dark-Sky Parks in Europe and the world is investigated, together with a presentation of a comparative qualitative analysis of selected Dark-Sky Parks in Croatia and other similar astro-destinations in Europe. The role of observatories in the development of astrotourism is also addressed, focusing on the examples of several selected observatories in Croatia, which mostly encourage in astrotourism. At the end of the paper, the authors provide guidelines and scientific implications of the conducted research. The limitation of the research is that only a few astro-tourist destinations in Croatia are researched, i.e. only those that have received a Dark-Sky Park certificate. It is necessary to consider that there are other forms of certification of destinations for astrotourism, but also several still uncertified destinations and entities that develop astrotourism as a complementary form to other forms of tourism - ecological, rural, coastal, and other forms. In these locations, astrotourism is offered in the form of specific events.

Methodologically, the authors used a comparative and qualitative analysis, as well as a multiple case study analysis, believing that it is a suitable tool for researching such still insufficiently researched phenomena. By being a matter of strategic management, both in terms of tourism development and in the context of the development of certain geographical areas, the authors have chosen the so-called template analysis, "which is widely used in management research" (Danelis et. al., 2004, cit. in Sang and Sitko, 2015, p.146), that "allows for textual data to be thematically organized and analyzed according to a set of codes developed a priori". (King, 2004, cit. in Sang and Sitko, 2015, p.146) Secondary data was used during data collection, primarily the websites of the described destinations and institutions relevant for astrotourism. Since the contextual approach is of great importance when addressing issues such as light pollution and astrotourism, the method of multiple case studies was used, in accordance to Dul and Hak (2008) who believe that the case study method "often involves detailed exploration, typically with information accumulated over a phase of time, of phenomena within their context", while Gillham (2001) claims for the same method that "the fundamental objective is to generate an analysis of the context and processes which enlighten the issue being researched". Yin believes that multiple case studies help to "advance theory through testable proposition" and continues by stating that "[t]his approach (multiple case studies\* author's note) is best suited to circumstances where there is limited knowledge about a phenomenon..." (Yin, 2009, quoted in Papachroni and Lochrie, 2015, p.81)

The paper consists of four parts. The first part presents a brief overview of the phenomenon of astrotourism, followed by a chapter on the issue of light pollution. The third chapter presents the results of the research, followed by guidelines and scientific implications of the paper together with a conclusion.

## 2. ASTROTOURISM AS A SELECTIVE FORM OF TOURISM

Paskova, Budinska and Zelenka (2021) state that the development of transport has led to the accelerated development of tourism and that in many countries over time tourism has become one of the key activities of the economy. Innovative forms of tourism are becoming increasingly

prominent, they can be classified as a selective form of tourism, and astrotourism stands out as one of the most interesting types among them. The research of astotourism has increased in the last ten years with the appearance of journal articles and books based on this selective type of tourism. Astrotourism is a new, selective form of tourism that is based on the observation of celestial bodies together with additional services, requiring the engagement of professional or amateur astronomers. As Krajnović and Hordov state: "Astrotourism is considered a sustainable activity and a specific form of ecotourism, with the four basic types of astrotourism being - spiritual sky-gazing or night star observation, amateur observation, astrophotography, and scientific astrotourism." (Krajnović and Hordov, 2021, p.210-211)

It is interesting to point out that cosmic phenomena have attracted people's attention since prehistoric times, as evidenced, according to the authors, by cave paintings, statues, myths, and related narrative arts as well as ancient calendars and sacred sites, apparently associated with the observation of cosmic phenomena. At the same time, knowledge of ancient astronomical observations and sites is constantly evolving dynamically by means of experimental archeology, aerial archeology, and geophysical methods, such as GPR (Ground Penetrating Radar also called *georadar*), 3D reconstructions and computer simulations. The purpose of using ancient sacred sites for astronomical observations is verified by virtual applications. Archaeoastronomy can also be a method of searching for probable sites of ancient monuments. (Pásková, Budinská and Zelenka, 2021)

According to Fayos Sola, Marin and Jafari (2014) astrotourism has expanded over the last few years, as the scientific community disseminates its objectives, knowledge, and ethics through society at large, and tourism entrepreneurs respond to increasing demand for meaningful tourism experiences. Astronomical phenomena, knowledge of space, cosmic tours of the stratosphere and nearby space, and today the combination with virtual tourism, whose occurrence is primarily caused by the COVID-19 pandemic, are considered typical attractions, motivations and activities of astrotourism. An example of how, during the time of the pandemic, astrotourism was carried out through virtual channels is the project named *Astronomitaly* and developed in Italy. Krajnović and Hordov (2021) while relating to this project state that "[r]egarding the products...the astronomical observations in 3D and VR can be highlighted...This is particularly important in the current situation of the COVID-19 virus pandemic since it offers the possibility to be able to, in lockdown conditions, experience the (adapted, virtual) tourist product of astrotourism from the comfort of one's own home." (Krajnović and Hordov, 2021, p.214) Krajnović (2020) further states that "...astrotourism is one of the selective forms of tourism that... achieves synergy with other forms of tourism and is in line with the growing trends and directions of development of mankind such as - the growing role of science and technology in modern society, the importance of education, the return of imagination, the pursuit of conservation and protection of natural and social resources, etc." Tadić distinguishes the terms 'space tourism' and 'astro-tourism' and states that they are new, special forms of tourism. He then continues by stating that "space tourism refers to space flights financed by individuals ('private astronauts') for their satisfaction/fun. By paying dearly for their trips, space tourists become co-financiers of serious space programs ('spaceflight participant', 'commercial astronaut'). On the contrary, astro-tourists do not depart from the Earth but attend specially designed lectures at planetariums, visit both modern and ancient astronomical observatories, and learn about the organization of work and astronomical instruments. All these preparations are conducted in order to enable tourists to observe celestial bodies, under professional guidance, for personal satisfaction or fun (Belij & Tadić, 2015, quoted in Tadić, 2016, p.129). Finally, astrotourists go "outdoors i.e. to the countryside, outside a city to avoid artificial light from large cities and polluted atmospheres, which prevent people from seeing the night sky in its full beauty." (Cinzano, 2002, quoted in Tadić, 2016, pp.128-129)

In their paper, Korlević and Krajnović (1999) describe the beginnings of the development of astrotourism in Croatia on the example of the Višnjan Observatory, a scientific institution of exceptional importance which at that time ranked third in the world in terms of scientific discoveries, behind NASA and the US Army, a fact that in itself is a curiosity and to this day attracts many visitors - school groups, occasional travelers and others. Korlević (who is also the head of that particular Observatory) and Krajnović further elaborate: "The possibility of presenting the discoveries and other astronomical

curiosities in a popular scientific way, with the help of modern multimedia presentation equipment, adds an exceptional educational and tourist value to the Observatory, in accordance with the desires and needs of modern tourists wanting to experience something new and unique during their tourist trip and stay. Similar projects in the world, especially in the USA, Australia, and Great Britain, have already come to life and are an integral part of the tourist offer." (Korlević and Krajnović, 1999, p.86)

### 3. THE ISSUE OF LIGHT POLLUTION

Light pollution is a problem that is still relatively unknown, although recently scientists and experts are starting to increasingly focus on the issue through the use of a multidisciplinary approach. This specific type of pollution is both an environmental and public health problem, while also being closely related to the development of astronomy and astrotourism. The night sky is a necessary condition for the undisturbed observation of space bodies, regardless of whether it is a scientific or recreational type of observation. The Environmental Protection Act defines light pollution as follows: "Light pollution is a change in the level of natural light at night caused by the introduction of light produced by human activity." (Andrejić et al., 2010, quoted in Krajnović, 2020, p.333)

The main feature of light pollution is the increase in the brightness of the sky during the night caused by inadequate artificial lighting. At the global level, the umbrella organization dealing with the issue of light pollution is the *International Dark-Sky Association*, and the issue of light pollution itself is defined by the so-called *Starlight Declaration* adopted in 2007. The fight against light pollution includes environmental, legal, strategic, educational, and other aspects. The IDA website states: "The inappropriate or excessive use of artificial light - known as light pollution - can have serious environmental consequences for humans, wildlife, and our climate. Components of light pollution include Glare - excessive brightness that causes visual discomfort; Skyglow - brightening of the night sky over inhabited areas; Light trespass - light falling where it is not intended or needed; Clutter - bright, confusing, and excessive groupings of light sources. Light pollution is a side effect of industrial civilization. Its sources include building exterior and interior lighting, advertising, commercial properties, offices, factories, streetlights, and illuminated sporting venues." (IDA, 2021)

In the Republic of Croatia, the issue of protection against light pollution is addressed by *Our Sky - Association for the Protection of the Night Sky*. The *Association* aims to "preserve the natural night sky and landscape, nature, environment, and biodiversity as fundamental values of society, and acceptable management of natural resources by applying the determinants of sustainable development and energy efficiency, and encouraging innovation in the field of lighting technologies." (<http://www.nasenebo.hr/?file=kop2.php>)

The first congress on light pollution was organized in Croatia only recently in 2019, in Rab. During the opening announcements of the Congress, Korado Korlević, one of the first initiators and promoters of this issue in Croatia, stated the following: "Before us is the *First Croatian Congress on Light Pollution*, a place where we will be able to analyze light pollution for the first time, an issue that has been neglected from a multidisciplinary point of view in all its breadth, starting with the protection of human health to the cultural impact on the community. Although it took twenty years from the first articles in the Croatian media and the involvement of UNESCO in this matter, for a law to be decreed and for this gathering to take place, this was not a waste of time. In the meantime, many experts and people of goodwill have contributed from professional texts related to the light engineering profession, to texts on cultural and homeland related protection of the night, as well as with philosophical and theological texts posing the question 'Can there be light without darkness?'" (<https://rabsvjetlosnooneciscenje.wordpress.com/>)

A significant contribution to this issue, and one of the most important initiatives at the global level in this regard relates to the so-called *Starlight Declaration*, or more precisely *Starlight Declaration: In Defense of the Night Sky and the Right to Starlight*, also called the *La Palma Declaration*, adopted in 2007 in La Palma, Spain, under the motto: 'In defense of the night sky and the right to the light of the stars'

that considers the right to a dark night sky a right of humanity ('a common heritage'). (www.starlight2007.net)

## 4. RESEARCH RESULTS

The results of the research are presented below, with the presentation structured in four segments. The first segment describes the requirements of IDA for obtaining a Dark-Sky Park certificate, followed, in the second part, by an overview of European and worldwide Dark-Sky Parks. The third segment presents the Dark-Sky Parks in Croatia, together with a descriptive and comparative analysis of several case studies - selected Dark-Sky Parks in Europe comparable to those in Croatia.

### 4.1. IDA and the requirements for obtaining a Dark-Sky Park certificate

IDA was founded in 1988 and since then has been offering certificates, in different categories, to sites that specifically protect the night sky, under the motto: "*The International Dark Sky Places* conservation program recognizes and promotes excellent stewardship of the night sky." The aim of *The International Dark Sky Places (IDSP) Program*, established in 2001, is, as stated in the IDA, "to encourage communities, parks and protected areas around the world to preserve and protect dark sites through responsible lighting policies and public education". The categories to be awarded are as follows: *International Dark-Sky Communities* (Communities are legally organized cities and towns that adopt quality outdoor lighting ordinances and undertake efforts to educate residents about the importance of dark skies), *International Dark-Sky Parks* (Parks are publicly-or privately-owned spaces protected for natural conservation that implement good outdoor lighting and provide dark-sky programs for visitors), *International Dark-Sky Reserves* (Reserves consist of a dark "core" zone surrounded by a populated periphery where policy controls are enacted to protect the darkness of the core), *International Dark-Sky Sanctuaries* (*Sanctuaries* are the most remote (and often darkest) places in the world whose conservation state is most fragile), *Urban Night-Sky Places (UNSPs)* (UNSPs are sites near or surrounded by large urban environs whose planning and design actively promote an authentic nighttime experience in the midst of significant artificial light at night, and that otherwise do not qualify for designation within any other International Dark-Sky Places category). In addition, the program previously included one additional designation category: *Dark-Sky Friendly Developments of Distinction* (retired 2020). (IDA, 2021)

Dark-Sky Parks are the focus of this analysis. To obtain a Dark-Sky Park Certificate, certain conditions need to be met. According to a written IDA guide from 2018 - „All protected public lands, whether managed by national, state, provincial, or local agencies, are eligible. These may include parks, refuges, forests, wilderness areas, monuments, protected rivers, or other categories of protected lands. Private lands whose owners consent to regular nighttime public access to designated areas of their property in perpetuity are also eligible." (IDA, 2021) One of the prerequisites for obtaining the category of a Dark-Sky Park is the existence of a quality comprehensive *Lighting Management Plan (LMP)* that must meet the prescribed standards. Among the conditions for obtaining a certificate are the following: "Typical nighttime conditions characterizing the site must be consistent with or exceed the following criteria: A) The Milky Way is readily visible to the unaided eye; B) There are no nearby artificial light sources yielding significant glare..." ... "At least two-thirds (67%) of existing outdoor lighting fixtures within Park boundaries conform to the Park's LMP at the time of IDSP application (or an alternative fraction approved by the Dark-Sky Places Committee." It is interesting that the IDA also envisaged a system of audits and monitoring, and in particular the measurement of light pollution levels: "A measurement program must be maintained either by the Park, private landowner(s), or by another public or private organization (university, research center, IDA chapter, astronomy club, etc.) to follow the evolution of light pollution in the IDSP and assure that the night sky quality does not degrade." The obligation of annual reporting and detailing activities and progress towards fulfilling IDA IDSP goals during the previous year is also prescribed. Through its conditions, IDA also takes care of current and potential threats to the dark sky in Dark-Sky Parks, while stating that it is necessary to establish "a



description of current and suspected future threats to dark skies over the park". Furthermore, among the conditions the educational element stands out, which is prescribed through the obligation of "producing at least one "night-sky friendly" lighting project that is publicly visible and interpreted." Cooperation is also a requirement – "Involving at least two external partners in dark-sky restoration efforts. Cooperation with at least two nearby municipalities that results in the adoption of lighting policies that improve sky conditions in the Park." Yet another condition is the commitment of the Park administration to public education, with the dark sky being one of the central themes: "If the Park typically provides interpretive programs, then dark-skies must be one of the central themes communicated through on-site interpretation, and at least a portion of the event must include dark-sky awareness or preservation specifically including reference to IDA and what it means to be an International Dark-Sky Park." The signalization is also proscribed by the conditions: "...the Park must erect and maintain appropriate public signage indicating the International Dark-Sky Park designation along a roadway entrance, along a footpath entrance if no roadway exists, or at a visitor contact center." (IDA, 2021)

## 4.2. An overview of European and worldwide Dark-Sky Parks

What follows is an overview of the most famous European Dark-Sky Parks which were awarded the *IUCN Dark Skies Advisory Group* certificate. This is an *International Association of Dark-Sky Parks Initiative*, which is made up, as stated on the Group's website, by "a network of individuals and groups that work to reduce light pollution in their respective countries." It is interesting to point out that the Initiative is coordinated from Slovenia, being the first country to have a strong light pollution law in force on a nationwide level. ([www.darkskyparks.org](http://www.darkskyparks.org))

Table 1 An overview of the most famous dark-sky parks in Europe with an IDA certificate (in accordance to IUCN) – data from February 2020

Country	Name	Year of obtaining the certificate
Czech Republic	Beskydy Dark-Sky Park	2013.
	Izera Dark-Sky Park	2009.
Denmark	MØn and Nyord International Dark-Sky Park	2017.
Germany	Eifel International Dark-Sky Park	2014.
	Winklmoosalm International Dark-Sky Park	2018.
Hungary	Bükk Starry Sky Park	2017.
	Hortobágy Starry Sky Park	2011.
Ireland	Zselic Starry Sky Park	2009.
	Mayo International Dark-Sky Park	2014.
Netherlands	Dark-Sky Park De Boschplaat	2015.
	Lauwersmeer National Park International Dark-Sky Park	2016.
Poland	Izera Dark-Sky Park	2009.
Portugal	Vale do Tua Starlight Tourism Destination	2020.
	Davagh International Dark-Sky Park	2020.
United Kingdom	Elan Valley za International Dark-Sky Park	2015.
	Northumberland International Dark-Sky Park	2013.

Source: Research conducted by authors according to WorldAtlas Dark Sky Parks in Europe

It is useful to point out that the *Dark Skies Advisory Group* offers a subdivision of dark-sky parks, which, as they say, "allow comparisons between different naming styles used by various recognizing bodies." The group offers an official classification of astrotourist destinations as follows: 1. Dark-Sky Astronomy Site: having a science-quality astronomical observatory; 2. Dark-Sky Park: protected natural area: 2a. Park, reserve, habitat, natural area, or other ecological or geological protection; 2b. An unpopulated area set aside for traditional or sacred practices related to the sky; 2c. Rural area, area of outstanding landscape beauty; 3. Dark-Sky Heritage Site:

protected heritage physical works of mankind; 4. Dark-Sky Outreach Site: 4a. Urban or suburban site; 4b. Rural site; 5. Dark-Sky Reserve: core protected area and a sustainable development buffer zone of cooperating community, rural and natural area jurisdictions; 6. Dark-Sky Community: a rural municipality, village, town, or city; 6a. City, town, or village; 6b. Populated rural area without a formally protected area. ([www.darkskeyparks.org](http://www.darkskeyparks.org))

Table 2 An overview of worldwide Dark-Skies Parks with a certificate (except Europe)

Country	Name of the park	Year of obtaining the certificate for minimally one Dark-Sky Park
Australia	The Jump up International Dark-Sky Sanctuary Warrumbungle National Park International Dark-Sky Park	2016, 2019
Canada	Ann and Sandy Cross Conservation Area Nocturnal Preserve Beaver Hills Dark-Sky Preserve Bruce Peninsula Dark-Sky Preserve Cypress Hills Dark-Sky Preserve Fundy Dark-Sky Preserve Grasslands National Park of Canada Jasper Dark-Sky Preserve Kejimikujik Dark-Sky Preserve Killarney Dark-Sky Preserve Kouchibouguac Dark-Sky Preserve Lake Superior Provincial Park Dark-Sky Preserve Lakeland Dark-Sky Preserve Mount Carleton Dark-Sky Preserve Old Man on his Back Conservation Area Nocturnal Preserve Point Pelee Dark-Sky Preserve Spruce Woods Dark-Sky Preserve Terra Nova Dark-Sky Preserve Torrance Barrens Dark-Sky Preserve Waterton Lakes National Park International Dark-Sky Park Wood Buffalo Dark-Sky Reserve	1999, 2005, 2006, 2009, 2010, 2011, 2013, 2015, 2016, 2017, 2018, 2020
Chile	Alto Loa Starlight Tourism Destination	2014
China	Taihang Conservation Area for Dark and Starry Sky	2018
Columbia	Desierto de la Tatacoa Starlight Tourism Destination	2019
Israel	Ramon Crater International Dark-Sky Park	2017
Japan	Iriomote – Ishigaki National Park International Dark-Sky Park Kozushima International Dark-Sky Park	2018, 2020
Namibia	NamibRand International Dark-Sky Reserve	2012
New Zealand	Aotea/Great Barrier Island International Dark-Sky Sanctuary Stewart Island/Rakiura Island International Dark-Sky Sanctuary Wai-iti International Dark-Sky Park	2017, 2019, 2020
South Africa	Khomani Cultural Landscape World Heritage Site	2019
USA	Antelope Island International Dark-Sky Park Anza – Borrego Desert State Park International Dark-Sky Park Arches National Park International Dark-Sky Park Big Bend International Dark-Sky Park Big Cypress National Preserve International Dark-Sky Park Black Canyon of the Gunnison International Dark-Sky Park Boundary Waters Canve Area International Dark-Sky Sanctuary Bryce Canyon National Park International Dark-Sky Park Buffalo National Scenic River International Dark-Sky Park Canyonlands International Dark-Sky Park Capitol Reef International Sky Park	1993, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020

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Capulin Volcano National Monument International Dark-Sky Park  
Cedar Breaks National Monument International Dark-Sky Park  
Cherry Springs Dark-Sky Park  
Clayton Lake Dark-Sky Park  
Copper Breaks International Dark-Sky Park  
Cosmic Campground International Dark-Sky Sanctuary  
Craters Of The Moon National Monument International Dark-Sky  
Park  
Dark-Sky Coast  
Dead Horse Point State Park International Dark-Sky Park  
Death Valley International Dark-Sky Park  
Devil's River State Natural Area International Dark-Sky Sanctuary  
Dinosaur National Monument International Dark-Sky Park  
Dr. T.K. Lawless International Dark-Sky Park  
East Canyon State Park International Dark-Sky Park  
Enchanted Rock International Dark-Sky Park  
Flagstaff Area National Monuments International Dark-Sky Park  
Glacier National Park International Dark-Sky Park  
Goblin Valley State Park International Dark-Sky Park  
Grand Canyon National Park International Dark-Sky Park  
Great Basin National Park International Dark-Sky Park  
Great Sand Dunes International Dark-Sky Park  
Headlands International Dark-Sky Park  
Jackson Lake State Park International Dark-Sky Park  
James River State Park International Dark-Sky Park  
Joshua Tree International Dark-Sky Park  
Kartchner Caverns International Dark-Sky Park  
Katahdin International Dark-Sky Sanctuary  
Kissimmee International Dark-Sky Park  
Lake Hudson Recreation Area Dark-Sky Preserve  
Massacre Rim Wilderness Area International Dark-Sky Sanctuary  
Middle Fork River Forest Preserve International Dark-Sky Park  
Natural Bridges Dark-Sky Park  
Negwegon Dark-Sky Preserve  
Newport State Park International Dark-Sky Park  
Obed Wild and Scenic River International Dark-Sky Park  
Oracle International Dark-Sky Park  
Parashant International Night Sky Province  
Petrified Forest National Park International Dark-sky Park  
Pickett-Pogue International Dark-Sky Park  
Port Crescent Dark-Sky Preserve  
Potawatomi Dark-Sky Preserve  
Rainbow Bridge International Dark-sky Sanctuary  
Rockport Dark-Sky Preserve  
Slumgullion Center International Dark-Sky Park  
South Llano River International Dark-Sky Park  
Staunton River International Dark-Sky Park  
Steinaker State Park International Dark-Sky Park  
Stephen C. Foster International Dark-Sky Park  
Thompson's Harbor Dark-Sky Preserve  
Timpanagos Cave International Dark-Sky Sanctuary  
Voyageurs International Dark-Sky Park  
Weber County North Fork Park International Dark-sky Park

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Source: Research conducted by authors according to IDA



From the displayed data, it can be concluded that Dark-Sky Parks in Europe are represented in different countries, while globally, the USA and Canada dominate.

### 4.3. Description and comparative analysis of selected European and Croatian Dark-Sky Parks

Table 3. shows a tabular overview of the only two dark-sky parks in the Republic of Croatia with an IDA certificate, as well as an overview of the leading Croatian observatories that have astrotourism as one of their segments.

Table 3 An overview of Dark-Sky Parks with a certificate, and the three most famous observatories in Croatia

County/City (location)	Dark-Sky Park	Observatory	Year of obtaining the certificate/opening
Bjelovar-Bilogora County	Vrani Kamen		2019.
Karlovac and Sisak-Moslavina counties	Petrova gora i Biljeg		2019.
Zagreb		Observatory Zagreb - Grič	1903.
Rijeka		Astronomy Center Rijeka	2009.
Višnjan/Tičan		Observatory Višnjan/Tičan	1992.

Source: Author's research according to available secondary data (web pages of displayed sites/institutions)

What follows is a descriptive analysis and comparison of the activities of the three mentioned Croatian observatories relating to astrotourism, as well as three selected well-known European Dark-Sky Parks and two Croatian Dark-Sky Parks that have met the IDA requirements for the Dark-Sky Park certificate. The emphasis will be on Eifel International Dark-Sky Park and Winklmoos-Alm International Dark-Sky Park in Germany, which received the certificate in 2014 and 2018, Bükk Starry-Sky Park in Hungary, which received the certificate in 2017, and two Croatian Dark-Sky Parks Vrani Kamen near Daruvar and Petrova gora and Biljeg, which stretch across the Karlovac county and the Sisak-Moslavina county, which received their certificate in 2019. In addition to these two Dark-Sky Parks, soon there should be another one in Lastovo, which on February 22<sup>nd</sup>, 2021 submitted again a request for an International Dark-Sky Park classification. These three were chosen because they are the closest in terms of years of recognition as Croatian Dark-Sky Parks, they have similar characteristics and similar content.

Regarding the observatories in this article, the selection was focused on the three most famous observatories that are active in the popularization of astronomy and astrotourism. The *Zagreb - Grič Observatory* is known for organizing summer astronomy schools, school astronomy competitions, camps, courses, as well as astronomical expeditions and observations. A cosmic radiation detector, which is also the first such instrument in Croatia, has also been installed next to the telescope. Both of these instruments also have an educational role as the Observatory is visited by thousands of students and citizens throughout the year, and thanks to that every visitor who comes can experience the universe in which we live. (Zagreb Observatory, 2021) *Astronomical Centre Rijeka* is the first and only astronomical centre in Croatia that unites an observatory, a planetarium, and the only digital planetarium. The *Centre* was awarded a special award in the category 'Tourist content or curiosity' at the county level of the 'Blue Flower' campaign, and it is the winner of the Society of Innovators 'Sigma 2011' award for the best marketing strategy in innovative business tourism. The program includes watching movies, interactive presentations, observations, lectures, exhibitions, etc., and is intended for education, entertainment, and socializing, and everyone is welcome. The Academic Astronomical Society of Rijeka also operates within it. (Astronomical Centre Rijeka, 2021) *The Višnjan/Tičan Observatory* in Istria, near Poreč, has

been operating for several decades. In addition to astronomy, a number of educational projects are being implemented. After operating for less than two years, it has ranked 15<sup>th</sup> in the world in terms of the number of published assistances in determining the orbits of newly discovered dangerous objects in the overall ranking, which shows the importance of its work and significance for astronomy in Croatia. The observatory has also a Summer School of Science. The usual program includes an introductory lecture on science and astronomy, a tour of the Observatory, telescope domes, and, if weather conditions allow, a telescope observation on the meadow in front of the Observatory. In case of daily visits, the Sun is also observed. (Višnjani Observatory, 2021)

The Eifel International Dark-Sky Park is the first such park in Germany and is located in west-central Germany near the Belgian border, more precisely the Federal State of North Rhine-Westphalia. It covers 110 square kilometers of territory. The National Park Supervisor Henning Walter believes that the IDA appointment will also have a significant impact beyond the Park's boundaries as many people will be able to enjoy the view of the beautiful starry sky and will pay more attention to reducing light pollution. This park is located in one of the most densely populated parts of Western Europe; nearly 20 million people live within two hours of the Eiffel by car or train. The location of the park near major population centers such as Aachen, Bonn, and Cologne presents a particular challenge in preserving this fragile natural treasure. This park received a Dark-Sky Park certificate thanks to Harald Bardenhagen who persuaded dozens of communities in and around the park to set limits on outdoor illumination to protect the park itself without compromising their safety. As stated by Bardenhagen himself - "This task does not only require spirit and enthusiasm to promote the dark-sky and the values of the night landscape without light pollution. The advantage of illumination alternatives should also be presented in order to prevent a wide range of problems caused by artificial light at night, such as energy waste, greenhouse gas emissions and potential damage to human health and biodiversity." According to the CEO, 200,000 visitors now enjoy the leisure and educational activities there each year, with options including night stargazing, nighttime bat watching, and ranger-led night walks. It is believed that this IDA nomination will bring new opportunities for tourism and economic development to the region, as well as help improve the overall quality of life. (IDA, 2021)

The first star-park in the Alps is *Winklmoos-Alm International Dark-Sky Park* in Germany. It spreads over 79 hectares of land. The beauty of the starry sky is preserved in the park, but also nature itself as a habitat for many diurnal and especially nocturnal animals. Thanks to farmers, caterers, residents, and others who have joined the Winklmoos Alpine Association, the buildings and surrounding areas have adequate 'star-aligned' illumination, significantly reducing light pollution and thus meeting the strict requirements of the IDA. On May 2<sup>nd</sup>, 2018, Dr. Andreas Hänel, an astronomer at the Osnabrück Planetarium and a spokesman for the *Dark-Sky Section*, presented the above-mentioned Association with a certificate from the International Dark-Sky Association. Public tours of this Dark-Sky Park, led by Manuel Philipp (physicist, astronomer, and founder of this Star Park) take place on Wednesdays and Fridays if the weather is nice and clear in order to have adequate clear sky visibility. Additionally, new benches have been set up in the Park to attract as many people as possible and enable them to observe the starry sky and the infinity of space even more comfortably. ([www.reitimwinkl.de/sternenpark](http://www.reitimwinkl.de/sternenpark)) Within the Park, the visitors can participate in weekly night astronomical events led by trained local staff, but also have the freedom to explore the area on their own, which encourages visitors' creativity and desire to experience everything around them with all their senses and to remember it forever. (IDA, 2021)

*Bükk National Park* covers 43,170 hectares of land in the Bükk Mountains in northern Hungary. It is located among the highest peaks of the country and it is densely forested. It is home to twenty species of nesting birds, many of which are endangered. Visitors can find a variety of outdoor and cultural activities throughout the park. The proposed content includes more and more events that allow visitors to get closer to the dark night sky. This park was certified thanks to the local Association for the Protection of Nature and Culture and the Directorate of Bükk National Park, which in 2014 signed a contract to research and document lightning and light pollution in the

park after recommendations were made for subsequent installation of illumination within it. (IDA, 2021) Continuous efforts are being made to add new content, with the number of star and night events constantly increasing, and people from all over Europe coming to this Dark-Sky Park to enjoy the beautiful expanses of the starry sky and space. The park tries to attract many visitors by offering more options for casual visitors, but also real amateur astronomers. (IDA, 2021)

The first Croatian Dark-Sky Park is *Vrani kamen* and it is located near the town of Daruvar, covering 8,000 hectares of the western part of the Papuk mountain. This park is mostly state-owned and managed by *Hrvatske šume (Croatian Forests)*, while the area of the mountain peak Petrov vrh is managed by the Daruvar authorities. In addition to the rich flora and fauna, this Park is a great place for astronomers and astrophotographers who enjoy observing and photographing the beautiful night starry sky. Astronomers have been using this pearl of nature for many years and the fact that it has been preserved from unnecessary light pollution for many years is highly appreciated. Another important thing is that many photographs of the night sky, as well as space objects, were taken in this area. The most visited place is Petrov vrh, where there is also a mountain lodge where nature lovers and astronomy lovers can enjoy themselves, where they can find refuge and refreshment, and even sleep over if needed. This place is convenient due to the proximity of the night observation location. One of the extremely important activities of this *International Dark-Sky Park*, as mentioned above, is to raise awareness about light pollution and the need to protect exceptional night landscapes for future generations, as well as to improve the quality of life through education in order to inspire and empower the community. Acting under the slogan "Turn off the lights, turn on the stars" is an important step towards a quality night sky, which has been recognized by the Daruvar authorities who are constantly improving the environment to make the experience of the starry sky complete. It can be noticed that this Park, unlike the previously described parks, is much better promoted and the whole Park is presented in much more detail, and thus it is more accessible to people and they are better acquainted with it. Daruvar, and thus the *International Dark-Sky Park Vrani kamen*, is "a place where people come to refresh their body, soul and mind, relieve stress, but also stimulate the imagination and enjoy the journey to the infinite space called the Universe." (IDA, 2021)

Another Croatian Dark-Sky Park is *Petrova gora* located near the city of Zagreb. It represents an additional value for tourist visits and scientific activities in this locality. It is important to emphasize that, unlike the previously described international Dark-Sky Parks, Petrova gora has been used for astronomical activities since 2007 and is, therefore, one of the most popular places in Croatia for star observation and astrophotography. It is interesting to note that this Dark-Sky Park is located within two counties and, accordingly, it is managed by two associated public institutions – the Public Institution Natura Viva, which manages the protected natural values of Karlovac County and the Public Institution for the Management of Protected Natural Values of the Sisak-Moslavina County. The forest land is managed by Hrvatske šume (Croatian Forests). The initiator of the certification process was the Astronomical Society Beskraj from Zagreb. The obtaining of the International Dark-Sky Park certificate meant that all four institutions were cooperating in the protection of the night sky in the area. The international designation of the Dark-Sky Park for Petrova Gora, as well as for other Dark-Sky Parks, aims at raising awareness of the importance of preserving the starry sky in the whole country as well as in the whole of Europe. (IDA, 2021)

Table 4. shows the results of a comparative analysis of European and Croatian Dark-Sky Parks, according to the criteria defined by the authors.

Table 4 The comparative analysis of 3 European and 2 Croatian Dark-Sky Parks according to the criteria defined by the authors

Park/ State	Year of obtaining the certificate	Size	Management	Main program	Promotion	Perspectives and challenges
Eifel/ Germany	2014	110 square kilometers	National Park Work Group and Municipal Board	Night observation of the stars. Night observation of bats. Night walks led by rangers.	Only the official website of the park and the IDA website, there is no particularly significant promotion.	New opportunities for tourism and economic development of the region and improvement of the overall quality of life.
Winklmoos – Alm/ Germany	2018	0,79 square kilometers	Manuel Philipp i Reit im Winkl	Experience the universe with all your senses. Star tours. Astronomy courses. Astronomical lectures. Astronomy shop.	Official site. Facebook page. Podcast. Astro shop.	Improving the quality of life. Conservation of endangered species of alpine flora.
Bükk/ Hungary	2017	431,3 square kilometers	Bükk National Park Directorate and several privately contracted individuals.	Evenings of stargazing with a telescope.	Official site, there is no particularly significant promotion.	Improving the quality of life. People awareness about environmental pollution affects everyone. People awareness about how important it is to protect the dark sky. Protection of nature, landscape, and cultural heritage. Launching of an astronomical center.
Vrani kamen/ Croatia	2019	80 square kilometers	Croatian forests and Daruvar authorities.	Observing and photographing the beautiful night sky. Mountain lodge in case someone wants to sleep over and enjoy the view of the starry sky for several days.	Detailed official page. More accessible information on the internet, as opposed to 3 European Dark-Sky Parks.	Raising awareness about light pollution and the need to protect exceptional night landscapes for future generations. Improving the quality of life through education. Landscape and cultural heritage protection.
Petrova Gora-Biljeg/ Croatia	2019	2734,91 square kilometers	<i>Public Institution Natura Viva. Public institution for the Management of Protected Natural Values. Croatian Forests.</i>	“Star parties.” Summer observation of shooting stars ‘Tears of St. Lawrence’. Educational excursions. Introducing all generations to astronomy - the oldest science.	A large number of websites about the park itself and relating events. Facebook page - The Dark Side of the World. Official site of the <i>Astronomical Society “Infinity”</i> . Astronomical activities since 2007	Protection of the dark sky as part of the natural habitat and flora and fauna. Preserving the beauty of the starry sky for present and future generations. Light pollution control.

Source: Research conducted by authors according to available secondary data

## 5. DISCUSSION

The issue of light pollution should be approached systematically and strategically, involving all relevant stakeholders. The issue of astrotourism is a continuation of the issue of light pollution, so obtaining a Dark-Sky Park certificate is part of the effort to simultaneously achieve two important strategic goals: protection from light pollution and the development of astrotourism. Croatia has

adopted one of the most advanced national laws regarding light pollution. This Act requires that all protected areas in Croatia have fully protected lighting fixtures with a maximum CCT of 2200K, and prohibits lighting on billboards. During the *First Croatian Congress on Light Pollution*, conclusions and directions for further action were reached when it comes to this ecological and cultural phenomenon. It is especially useful to note the comparison of the European recommendations for public lighting and Croatian practices, where the Republic of Croatia still does not adhere to most of these recommendations, although it has adopted the relevant law. One of the most important activities to be undertaken is to prescribe the technical conditions for public lighting. More precisely, the problem of light pollution should be solved first, and parallel to that, and based on these efforts, astrotourism should be developed.

When it comes to astrotourism, it is important to mention the significant role of non-governmental organizations, such as *IDA - International Dark-Sky Association*, which, among other things, awards certificates of Dark-Sky Parks, and other certificates intended for astrotourist destinations. By considering the research presented in this paper, it can be concluded that the most important astro-tourist destinations are Dark-Sky Parks, with their continuously growing numbers throughout the world, particularly in the USA and Canada. Europe is developing astrotourism in several different countries, with a number of extraordinary locations, described in this paper, which have a long tradition of popularizing astronomical science and professional and amateur observations of space. Croatia does not lag behind other countries when it comes to astrotourism, because it has already made significant efforts in organizing astrotourism visits and events. However, it would certainly be very important to support a broader platform at all levels, with a more significant involvement of the Croatian National Tourist Board and tourism communities at the meso and micro levels. Thanks to the efforts of many enthusiasts across the country, Croatia can boast several localities and institutions that develop astrotourism tours and events. Two locations in particular need to be pointed out – the only two so far, Dark-Sky Parks in Croatia - Vrana Kamen and Petrova Gora, as well as observatories/astronomical societies, especially those in Zagreb, Rijeka, and Višnjan/Tičan in Istria. Lastovo is also competing for the Dark-Sky Park certificate, and it should be noted that there are initiatives and projects within astrotourism in some other localities and tourist destinations in Croatia. Unfortunately, they are not combined into a single project, as it has been done in Italy, Spain, and some other countries, and that is something that needs to be remedied. In addition to the support of the tourism system, the support of public authorities, scientific and educational institutions, associations and individuals, as well as the local population is also very important for the development of astrotourism, because, ultimately, the local population should be most interested in protecting their skies from excessive and inadequate night lighting.

When it comes to the development of astrotourism, the recommendations can be found in the *Starlight Declaration*, and they need to be followed. The main recommendations of the *Declaration* are as follows:

- a. An unpolluted night sky that allows the enjoyment and contemplation of the firmament should be considered an inalienable right equivalent to all other socio-cultural and environmental rights. Hence the progressive degradation of the night sky must be regarded as a fundamental loss.
- b. Knowledge - armed with education - is a powerful vector that can heal the growing rift between today's society and science and contribute to the advancement of mankind as a whole. The dissemination of astronomy and the scientific and associated cultural values should be considered as basic contents to be included in educational activities.
- c. Control of obtrusive light must be a basic element of nature conservation policies since their impact on several species, habitats, ecosystems, and landscapes.
- d. Protection of the astronomical quality of areas suitable for the scientific observation of the Universe must be given priority in national and international scientific and environmental policies.



- e. The intelligent use of artificial lighting that minimizes sky glow and avoids obtrusive visual impact on both humans and wildlife should be promoted. This strategy would involve a more efficient use of energy to meet the wider commitments made on climate change, and for the protection of the environment.
- f. Tourism, among other players, can become a major instrument for a new alliance in defense of the quality of the nocturnal skyscape. Responsible tourism, in its many forms, can and should take on board the night sky as a resource to protect and value in all destinations.

Necessary measures should be implemented to involve all parties related to skyscape protection to raise public awareness—be it at local, regional, national, or international level—about the contents and objectives of the *International Conference in Defense of the Quality of the Night Sky and the Right to Observe Stars.*” (Dark Sky Awareness, 2009)

When it comes to Europe, it is interesting to point out the possibilities of using EU funds for the development of astrotourism. A good example of this is the *EUSky Route*, an EU project that started in 2013, which lasted 18 months. This project aims to draw a route of astronomical sites in Europe giving value to European Astronomy Heritage. The purpose of the project is “gathering both knowledge and observation of the current sky, and the knowledge acquired by the European wise people and scientists of all times that have been enabling and achieve a common social and economic development; be capable of binding new expectations of active leisure and the infrastructure that Europe has in the field of astronomy.” The main goal of the project is “to establish a route of European sites of astronomical interest based on quality tourist offer linked to the scientific European knowledge, while the specific objectives have been established to achieve it: incorporate and establish the European scientific knowledge on Astronomy to tourist and local leisure offer; expand and strengthen existing partnerships at European level of astronomy towards local development enhancing the tourism industry and leisure; establishment of a European route of sky observation groups adequate to the objective identified: singles & friends, families and retirees; incorporating new professionals to the cultural tourist offer; to develop a mobility system based on a “sustainable” and friendly with the environment criteria will a main goal (the observatories are usually located in natural parks); creating a tour package within the 5 countries involved and linked to the 3 target groups; attract new visitors towards new experiences outside the usual tourist circuit offered locally. (EUSky Route, 2013)

## 6. CONCLUSION

It can be concluded that the development of astrotourism is in full swing, and is especially driven by the COVID-19 pandemic which seeks new, creative forms of tourism, as opposed to the “spent” model of mass tourism. However, it should be noted that the development and growth of all selective forms of tourism, including astrotourism, will continue to depend on its professional integration into destination management and local, regional, and national governance systems.

It is therefore recommended that practitioners and scientists from various fields should be more significantly involved in sensitizing the scientific and general public about the problem of light pollution, so it is suggested that the recommendations of the *Starlight Declaration* be included in strategic documents at all levels, but also within scientific discussions. Scientists and practitioners should use an interdisciplinary approach, and simultaneously seek to improve the protection against light pollution, as well as to encourage the development of astrotourism and the protection of the night sky. National and international cooperation is crucial, as evidenced, for example, by the EU project *EUSky Route*, as well as the views and guidelines of the *International Declaration on the Protection of the Night Sky* (the so-called *Dark-Sky* or *LaPalma Declaration*). In this way we will be able to preserve our significant natural and cultural, but also tourism resource - a dark sky sprinkled with stars. In terms of the development of (alternative forms) of tourism, but also in terms of ecological and cultural protection of human rights to a clear night sky, we must follow

the motto of the famous Croatian writer A. B. Šimić - "Man, take care, not to go small under the stars. Let the starlight pour right through you!"

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