

BASES OF THE STARLIGHT INITIATIVE

CULTURAL DIMENSION

ENVIRONMENTAL CHALLENGES

SCIENTIFIC DIMENSION AND BENEFITS OF ASTRONOMY

THE RIGHT TO STARLIGHT

INTELLIGENT LIGHTING AND CLIMATE CHANGE

STARLIGHT DESTINATIONS

STARLIGHT RESERVES



The contents of this chapter corresponds to the working document of the Starlight Scientific Committee on the definition of the bases and objectives of the Initiative.

THE CULTURAL DIMENSION

The first hominid to lift its gaze to the sky, and its arms at the same time to get the stars, became the first man. Since that moment, the night sky has been one of the most important factors for the cultural, religious, spiritual and scientific development of mankind.

The sky is an integral part of the environment perceived by humanity. Mankind has always observed it, either to interpret it, or to understand the physical laws governing the universe. Nowadays we run the risk of reducing our everyday astronomical culture to the exclusive domain of a handful of scientific researchers. One of our most ancient and universal cultural values is threatened and may become extinct.

Interest in the sight of heavenly bodies has also powerfully influenced artistic manifestations. For uncountable generations human beings have looked at the starry sky like a source of inspiration for the most diverse aspects of their cultural heritage. The grandeur of the universe at night, and its powerful aesthetic appeal, has impregnated the development of art, music, poetry and dance throughout the centuries. The genius of Van Gogh would perhaps have not been the same without the clear skies of Provence and the shield of Achilles would have not looked so powerful without the stars dressed on it by the mastery of Vulcan, if we are to believe the verses of Homer. John Constable, the English painter, said that the sky “was the chief organ of sentiment”. But Man’s relation with the sky is constantly changing. Its previous mystical role has now been obscured by the realities of modern life.

A large part of our present-day generation is the first in history to grow up with no experience of the beauty of a starry sky shining overhead. The night sky should rightly continue to be one of the principal windows to the world for artistic creation.

Sky is a scientific subject for schools, but it is also an important reference for our cultural heritage. It is important to educate pupils in this field and it is especially interesting to



Galileo's telescope.

take into account this aspect in order to offer an interdisciplinary approach involving astronomy and ancient cultures in the school.

At the moment, in developed countries there is a decrease in the number of students interested in science. Astronomy is probably the most attractive and suggestive branch of science, and the most obvious element which could put people in contact with astronomy is the sky. But unfortunately the sky in developed countries is covered by a haze of pollution. Therefore, night sky defence should become a first-order educational objective.

Overall aims

- Identify and promote initiatives to enhance the value of tangible and intangible cultural heritage associated with astronomy, hence reinforcing our knowledge of the skies and of the associated cultural expression diversity.
- To reinforce the network of museums and observation centres open to visitors, in defence of the quality of the night sky.
- To promote the various forms of “cultural astronomy”, such as ethnoastronomy and archaeoastronomy.
- To promote the night sky dimension in education-related programmes.
- To identify and promote cultural manifestations related to the vision of the night sky.



From left to right, Juan Antonio Belmonte, Rosa María Ros, Margarita Metaxa, David Madacsi, Anna Sidorenko-Dulom, Ana Viña and Luis Ramallo, participating in the session: “The cultural dimension of the night sky” during the Starlight 2007 Conference.



Image: Pelican Nebula Ionization Front. University of Colorado, University of Hawaii and NOAO/AURA/NSF.

- To promote artistic manifestations based on the defence of the quality of the night sky as a creative resource and artistic right.
- To evaluate present-day indigenous artistic manifestations related to starlight.
- To develop and apply the Starlight Reserve concept in the areas associated to astronomical cultural heritage.
- To promote the presence of astronomy and of the cultural values associated to the observation of the firmament at all levels of the educational system.
- To support the dissemination of information related with cultural heritage associated to astronomy.
- To effectively promote and implement educational projects on preserving the night sky.

ENVIRONMENTAL DIMENSION

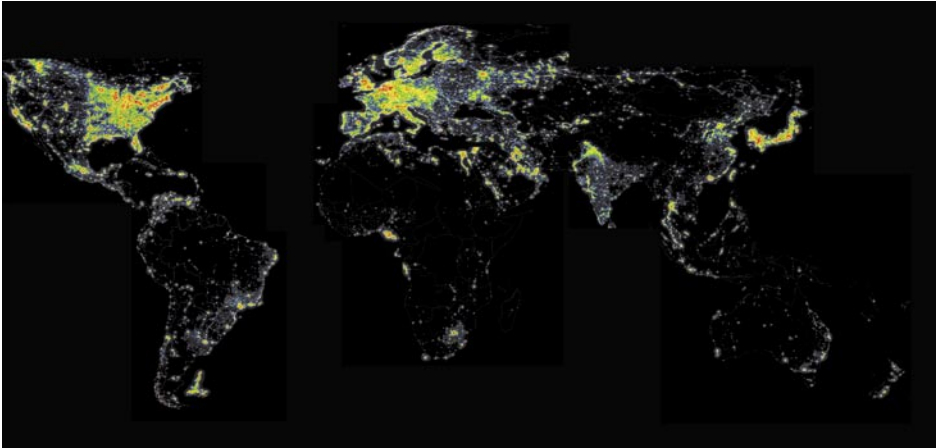
The negative effects of emissions and of the increased intrusion of artificial light on the atmospheric quality of nocturnal skies have become a serious threat for several species, habitats, and ecosystems. In the last years the scientific community sent the first alerts on the negative effects loss of clearness and quality of the night sky on biodiversity.

Darkness is indispensable for the healthy functioning of organisms and ecosystems. We usually forget that life lives 24 hours a day and that ecosystems adapted themselves to the natural rhythms of moon and stars during millions of years of evolution. As over half of the creatures living on this planet are nocturnal, any degradation in the quality of sky, by day or by night, will have a profound effect on their behaviour and on the equilibrium of the biosphere.

Light pollution in particular, turned out to be a factor with unpredictable consequences. Over the last decades, the degree and intensity of artificial light at night has increased



From left to right: Arnaldo Santos, Sharon E. Wise, David Welch, Travis Longcore (on-line), Felisa Hodgson, Antonio Righetti, Paola Deda, Peter Bridgewater, participating in the session: "Starlight and nature conservation. Preserving life diversity at night." during the Starlight 2007 Conference.



The World Atlas of the Artificial Night Sky Brightness. Credit: P. Cinzano, F. Falchi (University of Padova), C. D. Elvidge (NOAA National Geophysical Data Center, Boulder). Copyright Royal Astronomical Society. Reproduced from the Monthly Notices of the RAS by permission of Blackwell Science.

to such an extent that no-one can deny its present-day negative effects on habitats and species. A distinction must be made between the consequences of “astronomical light pollution”, which affects vision of the night sky considered as part of the landscape, and “ecological photopollution”, referring to alteration of natural light regimes in terrestrial and aquatic ecosystems.

Extensive information is now available on the effects of artificial lighting on certain migratory species guided by star light, or concerning such obvious phenomena as the mass mortality through dehydration suffered by certain sea turtles disorientated by light on their home beaches. Light pollution can for instance confound animal navigation (many species use the horizon and stars for orientation), alter competitive interactions and reproduction behaviour, change the natural predator-prey relationship and affect animal physiology. A number of nocturnal or crepuscular mammals such as bats, some primates, opossums as well as many rodents and marsupials suffer from what is now called “biological photopollution”.

But the spreading out of artificial light into the natural environment has other, obvious or less known, consequences. Among them, the noteworthy alteration of ascent and descent cycles of marine plankton, affecting the feeding of marine species, or the undesirable effects on population balance in certain species. Artificial light disturbance on the huge nocturnal insect fauna should be particularly emphasised. We have just started realizing and talking about the silent massacre that happens every night in the world.

We should be conscious that, if we insist in hiding the stars, we will end losing a substantial part of our natural heritage on Earth. Therefore the night sky quality dimension should be at least included in the management and conservation of protected areas and critical habitats. Ramsar wetlands, natural areas declared World Heritage Sites, Biosphere Reserves, National Parks, marine sanctuaries, and other protected areas have to face up to a new responsibility: saving life at night.

Overall aims

- To promote the inclusion of unspoilt night skies as a basic objective in biodiversity conservation strategies, and in measures designed to protect ecosystems and habitats of natural interest
- To increase knowledge and understanding of the scope of the ecological consequences of artificial light at night, a crucial conservation challenge opening new windows and opportunities for basic and applied research
- To propitiate research into the ecological dimensions of light pollution, fomenting collaboration among the natural, physical and engineering sciences.
- To propitiate the development of networks of protected areas which include the maintenance of unperturbed night skies in their management and conservation strategies.
- To develop inventory & monitoring networks able to identify the state and evolution of night sky quality as a vital sign in protected natural areas.
- To apply the Starlight Reserve concept in pilot areas identified within different categories and conventions: World Biosphere Reserve Network, World Heritage Sites, wetlands included in the Ramsar list and national Parks.



Public presentation of the Conference results by Miguel Clüsener-Godt. UNESCO - MaB (Man and Biosphere Programme)

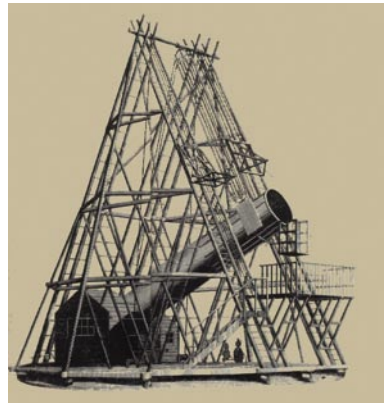
SCIENTIFIC DIMENSION AND BENEFITS OF ASTRONOMY

A dark sky for the development of astronomy.

The astronomical quality of an observatory is mainly defined by the transparency of its skies and the number of useful observation hours per year. This is closely related to local climatology and geographical characteristics, as well as to the absence of adverse factors affecting observation. The demands of sky quality for astronomical observation means that the number of locations in the world which can be considered excellent is substantially reduced, so that such places must be regarded as a limited resource requiring preservation.

The best locations for astronomical observation in the world, with regard to atmospheric stability and transmission, are of two types: high mountain areas isolated from the temperature of the ocean (for example, Mauna Kea in Hawaii, and La Palma in the Canary Islands), coastal mountains near to cold oceans with stable, subtropical anticyclone conditions (for example, the coasts of Chile, and the West of Mexico, the USA and Namibia) and zones with large lakes (as in the case of Panguitz Lake in Utah and Big Bear in California). Singular cases of exceptional quality can also be found, such as Monte Maidanak in Uzbekistan, or specific locations in areas as yet unevaluated, like North Africa or Argentina. However, the sky quality in many of these privileged zones can be perturbed by external factors of different kinds.

The best known is light pollution. According to the CIE (International Commission on Illumination), light pollution is a general term to denote the sum of all the adverse effects of artificial light. The most detrimental effects on astronomical observation are derived from the shine or glow of this light in the sky, caused by the reflection and diffusion of artificial light in atmospheric gases and particles. This glow, by reducing night darkness, prevents vision of the weakest sky objects, and contributes to the formation of perturbation lines close to others of astronomical interest. This form of pollution is the result of ineffective shading of external lighting, the use of inadequate luminaries and of excesses in light levels, meaning that part of the artificial light is projected upwards, thereby wasting light

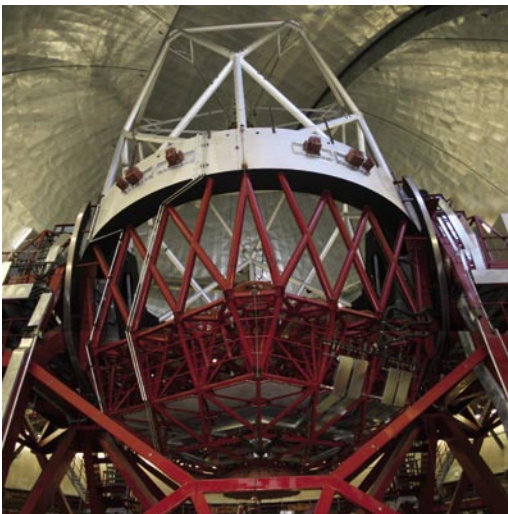
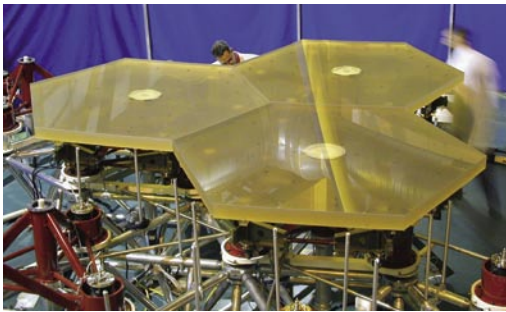


The reflecting telescope built in the 1780's by William Hershel.

intended for ground illumination of streets, squares and amenities, so that it ends up as an irrational deterioration vector for astronomical observation.

Radio astronomy made decisive contributions to several fundamental discoveries in the last century. Despite this fact, radio-electric pollution, that is, pollution produced by radio, television and mobile phone transmitters, among others, constitutes another factor which not only perturbs observatory measuring devices but also invades the radioelectric spectrum in which astrophysical observations are made. This phenomenon, which is undergoing constant increase worldwide as an undesirable by-product of the thriving telecommunications boom, poses a serious threat to observatories.

The third negative factor concerns atmospheric pollution produced by gas, smoke and other small particle emissions which reduce atmospheric transparency and decrease telescope observation capacity. Unfortunately, the sources of atmospheric pollution are often located at considerable distances from observatory sites themselves.



Above: View of three of the 36 segments that make up the primary mirror of the Gran Telescopio Canarias, arranged before aluminisation. Photograph by: SAGEM.

Below: The mechanical structure of the telescope, carrying the largest primary mirror in the world, during its phase of adjustment. Photograph by: Ángel L. Aldai.

Contrary to what happens in the field of conservation of natural areas, which can become irreversibly degraded through external threats, top astrophysical observation areas can always be recovered for science and humanity as Starlight Reserves. The ability to reverse the negative trends frequently depends on simple political decisions or on citizen responsibility in the conservation of this basic environmental resource.

Overall aims

- To consolidate, characterise and defend Starlight Reserves for astrophysical research, including not only existing observatory sites, but also potential locations.
- To promote, spread and develop codes, bylaws and laws safeguarding astronomical sites from the unnecessary effects of light pollution.
- To ensure frequency bands assigned to radio-astronomy remain free from undesirable interference in these zones, including that produced by telecommunication satellites, while defending the concept of internationally protected and restricted zones,



Photograph of the starry sky over La Palma taken on April 20th, 2007, the night when the Starlight Declaration was adopted. © Bob Crelin.

with regard to radio-electric pollution.

- To develop the concept of “international tolls on environmental consequences”.
- To promote alliances and agreements between government representatives, planners, observatories and astrophysical research centres, the relevant technical development institutions, and industry itself, in the search for viable solutions for the protection of astronomical Starlight Reserves.

Benefits beyond the frontiers of astronomy.

Scientific discoveries connected with astronomy have not only influenced the way we apprehend the universe, but also technology, mathematics, physics, and social development in general. Astronomy is a science which throughout human evolution has created, and continues to contribute, useful tools for human existence. From calendars to navigational instruments, or from modern communications systems based on satellites, to medical applications deriving from the latest techniques in image projection, astronomy has bestowed countless benefits on civilisation. Nowadays, the universe presents itself as an immense laboratory containing vast amounts of knowledge which, once unearthed, could be the source of new applications useful to society, or act as an effective driving force for technological and industrial development. Astronomy is precisely the vector providing access to these new advances and knowledge.

As to the benefits derived specifically from astrophysical observation, the development of materials such as pyrex, with its low coefficient of expansion, used in telescope

mirrors and for such everyday applications as vitroc ceramic cookers could be mentioned, or the new detectors which replace the human eye for capturing the very weak light reaching telescope foci, or infrared radiation technology impelled by the development of modern observatories. In general terms, the selfsame scientific instruments connected to the telescopes provide an excellent stimulus to many specialised industries which, while not necessarily leading to large-scale production of commercial instruments, does have the effect of generating a considerable increase in the technological capacity of the companies involved. To better understand the positive consequences of astrophysical observation, it only needs to be stated that financial turnover expected in coming years, purely in the development of large-scale astrophysical infrastructure with primary mirrors above 3.5m in diameter, presently under discussion and study, and scheduled for the next 15 years, amounts to a total investment, in 2006 figures, of more than 2,250 million euros.

Overall aims

- To help spreading and advertising the direct and indirect benefits to society as a whole coming from astronomy and astrophysical development, given that citizens themselves ought to assess the general usefulness of the advances in science and technology connected with astronomy.
- To foster the transfer of technology derived from astrophysical development, by way of new imaginative partnership formulae between the public and private sectors.
- To demonstrate that astrophysical development, with its diversity of related activities, always makes a positive contribution to the sustainable development and technological progress of the territories where observatories and research centres are located.



From left to right: Graham Bryant, Pedro Sahuenza, Friedel Pas, Francisco Javier Dfaz Castro, Antonia M^a Varela, Richard J. Wainscoat, Javier Méndez, Nigel Pollard, Chloé Legris, participating in the session: "Light pollution - intelligent lighting challenges." during the Starlight 2007 Conference.

LIGHT POLLUTION INTELLIGENT LIGHTING AND CLIMATE CHANGE

Among all factors affecting night sky quality, light pollution apparently is the meaningless one. Light pollution is the popular name for sky glow - a brightening of the night sky caused by artificial light being scattered by small particles in the air such as water droplets and dust. Light pollution also includes light intruding into our homes, such as a bright street light outside a bedroom window.

The current luminotechnical model favours dazzling, in the mistaken belief that an excess of light increases visibility for citizens, when in reality, the result is precisely the opposite. Supporters of the electric night base their thirst for illumination on concepts which have been shown in hundreds of studies to be erroneous and socially useless: concepts such as false security, expressed in the statement that profusely lit cities or roads make for safe cities, or the tendency to confuse light excess with standards of living, prosperity or wealth. Whatever the case, even accepting these arguments, it is utterly senseless to illuminate the sky by using inefficient and technically crude designs and lighting concepts, when the idea is to illuminate the ground, enclosed spaces or house interiors.

Today we have the technological ability to light intelligently and with a higher level of energy efficiency. It would be enough not to illuminate what does not need being illuminated, using appropriate luminaries and bulbs, or to be able to design lighting using common sense, avoiding the generation of another kind of noise.

The inability to focus light where it is needed is just as unintelligent as being unable to select the right light intensity for each situation, for an over-illuminated atmosphere can be even less safe, and obviously more unpleasant, than a rationally-lit area.

But if the procedures are observed from the point of view of energy consumption, the contradictions of our current outdoor lighting model can be perceived even more clearly. Avoiding light-pollution of the sky is one of the few environmental questions with an economically viable solution, especially when the concept of energy efficiency is added to that of eliminating "useless lighting". Most experiments involving the replacement of conventional public lighting with adequately-shaded lamps focussed where illumination is required, and having the additional benefit of low energy consumption, have shown that overall power consumption is reduced between 25 and 30%. Such a reduction not only affects the cost and sustainable management of energy resources, but obviously also has environmentally positive effects connected with reductions in greenhouse-effect gas emissions into the atmosphere which, as we know, constitute another detrimental factor affecting the quality of the night sky. The positive effect is further increased if very low-

polluting lamps are employed, such as low pressure sodium vapour models, rather than environmentally harmful ones, such as the mercury vapour or metal halide type.

During the last years, the experiences made in several regions and cities of our planet, such as the actions and campaigns carried out by the Dark Sky Association show that a change of attitude is possible without big efforts: “light up the night in a different way”.

The enjoyment of a dark sky therefore has a lot to do with our concept of rational energy use, not only in matters of intelligent lighting management, but also in aspects concerned with decisions regarding transport, or renewable energy options, which directly affect atmospheric quality. Thus, it could be stated that an energetically sustainable community is a community capable of enjoying the night sky. In fact, even if we only consider the lighting dimension, we must take into account that 19% of the world energy consumption is attributed to the electricity used to produce light at night. Then we can easily deduct that protecting night sky is part of the same battle that we fight against climate change. Preventing stars being stolen involves the mitigation of one of the causes of global warming.

Overall aims

- To promote and spread integrated codes, bylaws and standards regarding energy efficiency and savings, responsible lighting, and sky quality.
- To integrate the dimension of dark sky-responsible lighting into energy planning, and programmes promoting renewable energy, and energy saving and efficiency.
- To foment actions connected with intelligent illumination design, in both the architectural field and in urban planning, as well as in engineering, and the development and maintenance of infrastructure.
- To foment the commitment of local authorities in the choice of lighting systems, to ensure that “the public sector sets a good example”.
- To promote labelling in recognition of intelligent products and designs which preserve the quality of the illuminated sky.
- To promote and develop laws and bylaws regulating the requirements of outdoor lighting to guarantee the protection of night sky quality.
- To concert actions with the lighting industry sector following the line marked by the CIE (International Commission on Illumination).

THE RIGHT TO STARLIGHT

When the sun dips below the horizon, a large number of human settlements on the planet become artificially illuminated, creating a cone of light capable of eclipsing the subtle glimmer of stars. Every day, two thirds of the Earth's inhabitants never see the sky as it really is, a peculiar phenomenon which is aggravated in the European Union and the United States, where the firmament is never dark for 99% of the population. The most striking evidence of the destruction of our dark, starlit skies is provided by the disappearance of the Milky Way, which can only be admired in all its splendour at considerable distances from most urban areas.

To fight against light pollution means to pursue a common goal, by attempting to preserve for future generations the right to a purer environment. We all have the right to observe the stars, and we all have the right to include the starry, nocturnal skylscapes above our villages and towns among those memories processed by our own retinas. From this perspective, the right to a clear night sky has arisen in our times as a new social demand affecting standards of living, personal development, and the opportunities for enjoying a tremendous variety of landscapes which are presently hidden from view.

The right to a clear night sky is comparable with other environment-related rights. In addition to that, it deals with the conservation of a resource influencing lots of tangible and intangible cultural aspects throughout our planet. Progressive loss of the natural night sky is a threat to be faced in the same way as problems related with air and water quality or natural resource conservation are faced. Nowadays, talking about sustainable development also means talking about guaranteeing a clear night sky for ourselves and for future generations.

In recent years great efforts have been made to acknowledge this right and make it effective, transferring it to laws, regulations and by-laws that sought protection of this resource from several approaches. Many pioneer initiatives have come into being as an extension of astronomical observation requirements but, little by little, several cities and region not necessarily related with astrophysical observation areas, have joined this movement. All of them have the common goal to pursue a less polluted night sky, although the focus varies between those laws which pursue respect towards the night environment in a general way, those protecting observatories from polluting light sources, those which try to avoid energy waste, and those which attempt to protect a specific area (natural areas, lightscares, urban light oasis...).

In all cases, the pursued objectives lead to the enjoyment of clean, starry skies. It is therefore high time to take a further step forward, by defending the right to starlight in all

dimensions, as a cultural, scientific and environmental right, which includes quality of human life and enjoyment of nocturnal landscapes. In fact, it is not such a complicated task as it is the recovery of a threatened species, the fight against drought and erosion, or the loss of wild areas as a consequence of over-development: the night sky is 100% recoverable in all its dimensions.

Overall aims

- To regard light pollution as a troublesome, pernicious phenomenon in ambits regulating citizens’ welfare, with at least the same importance as noise production, vibrations, and contaminating emissions.
- To promote the right to personal and general enjoyment of clean night skies.
- To consider the diversity of clean sky nocturnal landscapes as a resource to be protected.
- To preserve the right to privacy by protecting citizens from intrusive light sources.
- To promote the idea of Starlight Reserves in all ranges, both urban and rural, and to consider the possibility of introducing “specially protected dark sky areas” into territorial planning, in the case of places with special scenic value which are still unpolluted.
- To generate an awareness of night sky protection on the part of local authorities, as a basic citizen’s right.
- To promote laws and bylaws oriented to night sky protection and to the effective control of light pollution.
- To promote the inclusion of night sky quality within environment-related international conventions.



From left to right:
 José María Garrido,
 Phil Cameron,
 Martin Morgan-Taylor,
 Hiroji Isozaki,
 Maguelonne Déjeant-Pons,
 participating in the session:
 “The Right to the Starlight.”
 during the Starlight
 2007 Conference.

STARLIGHT DESTINATIONS

Tourism, one of the most important and innovative activities on our planet, could act as the vector of a new alliance to promote the quality of the night sky. The sight of a clear sky can rightly constitute an asset for the development of specific products geared towards scientific or “knowledge tourism”, but it is also a frequently forgotten attraction influencing the quality of a tourist destination as an additional scenic element. At times, the starry sky forms part of the very essence of the tourist product, such as in the case of observations of the Northern Lights, visits to astronomical observatories, the multitude of sailing holidays featuring navigation by the stars, some pilgrimage routes, or the innovative visions offered by desert tourism.

The firmament, as a scenario for tourism in modern times, has been present as a basic reference point in historical destinations such as Santorini or Taormina. “Venezia, salvare la notte” (Venice, save the night), the slogan for one of the most important meetings in defence of the quality of the night sky, warned of the danger of forgetting the beauty and appeal of the night for an activity mobilising more than six hundred million people a year. This vital resource has almost fallen into oblivion due to tourism’s rapid development, standardising and massification. The present challenge is to reintroduce this resource as a basic part of the offer for those destinations which still have a chance to recover the clarity of their night sky.

The cultural heritage associated with astronomy also acts as motivation for many travellers nowadays. At present, there are many consolidated locations and destinations in which heritage connected with astronomy, including their archaeoastronomical heritage, constitutes the tourist attraction par excellence.

Observatories and their surroundings are also candidate areas for the development of innovative and respectful tourism activities, where, with intelligence, visits can be made compatible with the careful protection of the extraordinary natural conditions at such locations, and their quality for astronomical observation.

Overall aims

- To value the night sky as a tourist attraction and asset for destinations having adequate potential.
- To promote the exceptional nocturnal skylscapes as basic resources in a new generation of tourist products.

- To value and recover the material and immaterial cultural heritage connected with astronomy and star observation as a tourism resource.
- To promote formulae for responsible and knowledge tourism products related with astronomical observatories and significant areas for star observation.
- To incorporate the clean-sky criterion in the strategies of sustainable tourism destinations.
- To incorporate responsible lighting criteria in the certification and eco-labels of responsible tourism.
- Promoting a network of Starlight destinations.



Eduardo Fayos Sola, Director of Education and Knowledge Management UN-WTO (World Tourism Organization), during his introductory speech at the Opening Session of the Starlight Conference.



From left to right, Michael Iwand, Tomás Azcárate Bang, Jaime Sicilia Hernández, Dirk Spennemann, Carlos Fernández, Graeme Murray, Jafar Jafari and Virginie Lefebvre, participating in the session: “Star Routes. New tourism and knowledge dimensions of nightscapes.” during the Starlight 2007 Conference.



From left to right: W. Scott Kardel, Miguel Clüesener-Godt, Jose Luis Penacho Ródenas, César Portela, Arthouros Zervos and José Miguel Rodríguez Espinosa, participating in the session: “Night sky protection and sustainable development.” during the Starlight 2007 Conference.