

Application for Designation as
International Dark Sky Reserve

Rhön UNESCO Biosphere Reserve



Biosphärenreservat
Rhön



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Asteroid (5689) Rhön

is an asteroid in the main belt that was discovered at Tautenburg Observatory on 1991-09-09 by *Freimut Börngen* and *Lutz D. Schmadel*.

“Named for the range of young volcanic mountains that lie across Bavaria, Hesse and Thüringia. Name proposed by the first discoverer, who considers this region to be one of the most beautiful in Germany.” (Minor Planet Circular 22831)

Dr. Freimut Börngen worked as an astronomer at the Tautenburg observatory near Jena in Thüringia.

Another asteroid was named after the highest mountain which is famous for gliding: (10242) Wasserkuppe

Fig. 1: *Sabine Frank* demonstrates the uselessness of ground recessed spotlights.

This study has been prepared by *Sabine Frank* and *Andreas Hänel* with the help of *Martin Kremer* and many others. Pictures, if not otherwise credited, by *A. Hänel*

2 Summary

The Rhön Biosphere Reserve is situated in the center of Germany and stretches over the border triangle of three German federal states Bayern (Bavaria), Hessen (Hesse) and Thüringen (Thuringia). As there are no large cities in the vicinity, it offers relatively dark skies, despite its comparatively dense population (even more than the nature park Westhavelland) with 88 inhabitants/km² compared to other already recognized International Dark Sky Places. Nevertheless, the region is close to the more populated regions like the Rhein/Main region around Frankfurt or larger cities like Kassel, Erfurt or Würzburg, which are not further away than 1½ hours by car. Therefore the Rhön is an attractive destination for people of nearby cities. A students group of the University of Applied Science Fulda analyzed the potential of the Biosphere Reserve as a star park and concluded that the aims of both overlap and that it could become a good example for integrating both aspects of protecting and using natural resources.

The ARGE Rhön as the cooperation of the heads of the five county districts and the three biosphere administrations are convinced that becoming an International Dark Sky Place will help:

- to keep and restore the nocturnal environment in the Biosphere Reserve in a sustainable way,
- to conserve and improve dark skies and natural dark landscapes in the region and even in the whole nation,
- to raise awareness for the implications of artificial light at night,
- to raise awareness for and help installing environmental friendly and sustainable lighting in the Biosphere Reserve and to set up examples for other populated regions,
- to propagate dark sky and sustainable tourism in the Biosphere Reserve and elsewhere.

To accomplish this, the following strategy was followed:

1. Since March 2011 sky brightness measurements were taken over the area of the UNESCO Biosphere Reserve. Variations during different times of the night and during the seasons were identified and corrected. From these measurements the regions with the darkest skies could be identified which coincide well with the most protected areas in the Biosphere Reserve. They were fixed as the "starlight core zones E0" (to be distinguished from the Biosphere Reserve's core zones). The inner buffer zone E1 then corresponds to the area of the municipalities surrounding the core zones.
2. Lighting inventories were made for all artificial lighting in the core zones E0 and the municipalities in the buffer zone E1. Altogether more than 6000 luminaires of public lighting were registered and classified in order to identify the main contributors to the artificial sky brightness.
3. Detailed lighting guidelines were drawn up in 2012 for managing the artificial light to keep the core zones dark and reduce light pollution in the buffer zones. As municipalities often contract out public lighting to the local energy providers, it was clear, that it is of utmost importance to work together with them. Therefore, before introducing the lighting guidelines to the parliaments of the municipalities, they were intensively discussed with the local providers of lighting and the persons in charge at the Biosphere Reserve. From the view of the project, this fact is one of the most important ones for a long term and sustainable protection of the night sky in the Rhön. Once the lighting guidelines and their comments were printed, the process of introduction at the municipality parliaments begun. Most municipalities in the buffer zone E1 adopted the guidelines, in the outer buffer zone some municipalities also adopted them but this is still a continuing process. The advantage of this procedure is, that lots of political decision makers are confronted with the implications of artificial light at night, as most municipalities request a public hearing before voting.
4. Right from the beginning, presentations on light pollution and the concept of the dark sky program have been given and have been supported by various information materials in order to reach a big scale of various target groups and to get support from the population.
5. Different people offer astronomical topics to the local community: from the planetarium in Fulda, to naked eye observations and to the use of telescopes at very high technical level. The Rhön is known by many German amateur astronomers as an Eldorado for observing under dark sky conditions. Several educational establishments continuously offer astronomy programs to different groups, an international astronomy summer camp for the youth was already held several times in the Rhön. Exhibitions on light pollution were presented in the Biosphere Reserve's information centers and information material has been produced. A website www.sternenpark-rhoen.de is maintained. The idea of a star park in the Rhön, which was initiated by *Sabine Frank*, has already received considerable media coverage in regional and national newspapers, magazines, radio and TV stations long before working on this application.

The Rhön in the heart of Germany has for a long time being regarded as the poor house of Germany. The designation of the Rhön UNESCO Biosphere Reserve as an International Dark Sky Reserve would manifest it as a region where modern rural life and the protection of natural nightscapes and the sky above are not a contradiction – due to intelligent lighting and an environmentally friendly use of artificial light at night.

In this sense, designation would support the long process of installing better lighting - at a time when new technologies make lighting readily available and cheap.

Also, designation would motivate municipalities to carry on with their efforts that

- it would be possible to gain public funding for projects,
- it would show the Rhön people that they can be proud of the treasure above them,
- it would lead more people into perceiving and appreciating natural nights and nightscapes and
- it would show that despite all boundaries on the ground, the sky is limitless.

Because of its location in the heart of Germany it can well be expected, that the designation of the Rhön will radiate the meaning far beyond the borders of the UNESCO Biosphere Reserve.



Fig. 2.1: Startrails over the Wasserkuppe (foto: *Werner Klug*)

3 Nomination

Fachgruppe DARK SKY - Initiative gegen Lichtverschmutzung

www.lichtverschmutzung.de



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working group**
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2013-11-19

Nomination of the Rhön Biosphere Reserve as International Dark Sky Reserve

Dear IDA Board of Directors,

I would like to announce the nomination of the Rhön UNESCO Biosphere Reserve in the center of Germany as an International Dark Sky Reserve.

The idea of this project was developed 2010 by a student's study group from the University of Applied Sciences in Fulda. The study was initially about light pollution but also incorporated the idea of creating a Dark Sky Reserve. In March 2011, at the invitation of the Rhön Biosphere Reserve, I made studies of the night sky quality. The region proved to have one of the darkest skies in Germany with an extraordinary nature environment. The project was presented to the ARGE Rhön as the legislative body superior to the biosphere executive in June 2012 and it was approved unanimously to follow the aim of creating an International Dark Sky Reserve ("Sternenpark" = star park in German) within the Rhön UNESCO Biosphere Reserve.

The following requirements were given at starting point:

- An astronomical tradition through several astronomy groups around the park:
- Fulda planetarium, public and school observatories in Bad Salzschlirf, Meiningen, several private observatories, night hikes, night observation of bats and owls.
- Sabine Frank from the students study group offered public star and moon observation tours within the Rhön.

The Rhön Biosphere Reserve is spread over three Federal states. These are Bavaria, Hessia and Thuringia. In close cooperation with the three Biosphere Reserve administrations we took the following steps:

- Sky brightness measurements using SQM-Ls were taken over the most important parts of the reserve, showing nearly natural dark skies with a magnitude of up to 21.78 mag/arcsec² in spring evening skies. The identified dark core zones largely coincide with the protected core zones of the Biosphere Reserve. A report in German is available.
- Public awareness has been intensified and has been documented through many press resonance up to a national level. The public has also been informed by means of talks and press releases about the star park project and many public star observations were offered and further star guides were educated. An information leaflet was printed, showing the aims of the star park and also how the surrounding

populated areas could be environmentally lit with the aim of saving energy and preserving the night sky. Lists on the press resonance and the public presentations are available.

- In cooperation with the municipalities and the regional energy suppliers, that provide public lighting, inventories of the public lighting with several 6000 luminaires in the municipalities and the core zone were compiled. A summary is available.
- Lighting recommendations were elaborated in cooperation with the regional energy suppliers, who advice the municipalities about public lighting and at the same time provide public lighting, in 2012. They are based on the requirements of the IDSReserves guidelines (ver. 1.2) and actual scientific results. In addition to the guidelines, they contain requirements on the lighting quality by reducing the amount of blue light in specifying an upper limit of the cct of 3000 K. Over a thousand copies of the guidelines were printed and distributed to the municipalities and other decision makers in Biosphere Reserve in 2013. Constructive collaboration with these important players in public lighting has led to their decision, to no longer use lighting with more than 3000 K.
- As municipal councils have to recognize the lighting guidelines, they have to vote on and apply them within their communities. After the printing of the guidelines the process of presenting them to the municipalities for voting started in August 2013. This has proven to be a long but necessary process in order to really gain public and political support for the project. Up to now 7 (most within or at the boundary of the core zones) of the total 20 communities in the inner buffer zone E1 voted to follow the guidelines in the future.*
- Within the core zones and in the neighboring communities, replacement lighting according to the guidelines or simply switching off unnecessary lighting has already started (e.g. see Bischofsheim, Umweltzentrum Schwarzes Moor).

The present lighting guidelines are based on version 1.2 of the IDSReserve guidelines and unshielded lighting up to 1000 lm is allowed. It will not be possible to change the guidelines to the new recommended limit of 600 lm during the current voting process within the communities. Otherwise trust in the project could be lost.

In order to be able to progress with this project we need protection of confidence and therefore request to apply according to the guidelines ver. 1.2. This is bearing in mind the dimensions and administrative structure of the Rhön UNESCO Biosphere Reserve, which spreads over three Federal states and many communities.

The final or at least a provisional application should be ready in about 3-4 months when more communities will have voted to support the guidelines for an IDSReserve.

Supporting letters for the star park by the ARGE Rhön and the Biosphere Reserve administrations are attached.



Dr. Andreas Hänel

Astronomer and director of the planetarium in the Museum am Schölerberg, Osnabrück
Section leader of the working group Dark Sky Germany,
Member of the International Dark Sky Association IDA, Member of the International Planetarium Society IPS,
Member of the Astronomische Gesellschaft, Member of the International Astronomical Union IAU

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* added May 2014: meanwhile 16 of the 28 municipalities in the inner buffer zone E1 voted to follow the guidelines.



Landkreis Fulda · Groenhoff-Haus Wasserkuppe · 36129 Gersfeld

IDA
Board members

per E-Mail

LANDKREIS FULDA – DER LANDRAT

Fachdienst: **Biosphärenreservat und
Naturpark Hessische Rhön**
Bearbeiter: **Torsten Raab**
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Internet: **www.brrhoen.de**
Geschäftszeichen: **B-NZ-TUR/Sternenpark/ rh**

Gersfeld, 18.11.2013

Dear members of the IDA,

The UNESCO Biosphere Reserve Rhön fully supports the initiative to protect the natural nightscapes of the Rhön. We are situated in the middle of Germany and one of our greatest assets is the diversity of animal and plant species. Sustainable Development and the conservation of national systems and biodiversity are the main principles of the UNESCO program "Man and the Biosphere".

By supporting this project we are hoping to protect these species more than was able to be done in the past. We have come to learn in the course of this project, that artificial light does have a negative impact on diurnal and nocturnal animals as well as on people. We are also aware that public lighting needs to be more regulated than is currently. We therefore encourage the communities to accept and implement the lighting recommendations and also for private lighting. Also, we recognize that the starry night sky is of cultural good and we welcome people to come to the Rhön and enjoy a wonderful experience and a really dark sky.

We are very proud of this project and fully aware that it is something very special. We fully supporting this project by means of manpower, public outreach and our conviction for the application of the Biosphere Reserve Rhön as an IDS-Reserve.

Best regards
Im Auftrag



Torsten Raab
Head of the Biosphere Reserve Administration Hesse



Regionale Arbeitsgemeinschaft Rhön

ARGE Rhön – Obertshäuser Platz 1 – 98617 Meiningen

IDA Board Members
IDA International Headquarters
3223 N. First Avenue
Tucson, Arizona 85719
USA

Ihr Zeichen: Ihre Nachricht: Unser Zeichen: Telefon: Meiningen,
(Bitte bei Antwort angeben!) 0049 (0)3693/485 383 19.11.2013

Dark Sky Reserve in the UNESCO Biosphere Reserve Rhön

Dear ladies and gentlemen,

until now the night sky in the UNESCO Biosphere Reserve Rhön was not considered as a value of its own. Due to a strong and emotive campaign led by students, it was brought to our attention what a hidden jewel we have and how valuable the night sky is for humans as well as for animals.

As certain parts of the reserve have the potential of nearly naturally dark skies, we, as the legislative body of the biosphere reserve, initiated an application process to become an International Dark Sky Reserve.

Over the last two years many studies have been conducted within the Biosphere Reserve Rhön to measure the darkness of the night sky and locate the darkest spots of the reserve. This process has been accompanied by lectures to inform and allay fears concerning costs and changes to local communities within the reserve. In these presentations and in conjunction with leaflets and booklets we explained the guidelines that were required for the Biosphere Reserve Rhön to become a Dark Sky Reserve. Furthermore, star guiding tours are offered on a regular basis.

ARGE Rhön Vorsitzender: Landrat Peter Heimrich
Geschäftsführer: Heiko Kömmel

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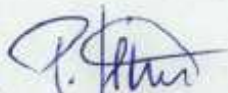
Landkreise: Fulda, Bad Kissingen, Rhön-Grabfeld, Schmalkalden-Meiningen, Wartburgkreis
Vereine: „Rhönforum e.V.“, Geisa, „Natur- und Lebensraum Rhön e.V.“, Gersfeld/Wasserkuppe,
„Naturpark und Biosphärenreservat Bayerische Rhön e.V.“, Oberelsbach

Die 
Regionale Arbeitsgemeinschaft Rhön

The ARGE Rhön with the political representatives of the five counties which are part of the biosphere reserve and the biosphere administration fully supports the application.

We hope that the organizational and financial engagement, as well as the achievements which have been made during the last two years, will not be put at risk, by the upcoming change of guidelines.

Sincerely



Peter Heimrich
(head of regional district)

4 Letters of Support



Natur- und Lebensraum Rhön e.V., D- 36129 Gersfeld

An den Vorsitzenden der Arbeitsgemeinschaft
„Rhöner Landkreise“

Herr Landrat Heimerich
Landratsamt
Schmalkalden-Meiningen
Obertshäuser Platz 1
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Natur- und
Lebensraum Rhön e.V.
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Datum: 19.03.2014
Az: /ELE

„Sternenpark Rhön“

Sehr geehrter Herr Landrat Heimerich,

der „Verein Natur und Lebensraum Rhön“ als Förder- und Trägerverein
des Biosphärenreservates Rhön, hessischer Teil, unterstützt die
Beantragung des „Sternenparks Rhön“ bei der *Dark Sky Association*.

Wir befürworten dieses Projekt und sehen in der Umsetzung für die Rhön
große Entwicklungschancen, sowohl im Bereich des Natur- und
Artenschutzes, als auch im Bereich der Regionalentwicklung und im
Bereich der Tourismusförderung.

Mit Blick auf die in Deutschland geplante Energiewende begrüßen wir
das Projekt, das in emotionaler Weise für die Einsparung für Energie
sowie die bessere Nutzung von Energie wirbt.

Folgerichtig hat der „Verein Natur und Lebensraum Rhön“ seit 2011 das
Projekt positiv begleitet und verpflichtet sich, die weiteren
Realisierungsschritte im Rahmen seiner Möglichkeiten tatkräftig zu
unterstützen

Mit freundlichen Grüßen

Martin Kremer
Geschäftsführer



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EIN BIOSPHÄRENRESERVAT
DER UNESCO



Translation:

Verein Natur- und Lebensraum Rhön

District Chief Executive Heimrich
of the District of Schmalkalden-Meiningen
Obertshäuser Platz 1
98617 Meiningen

“Dark Sky Reserve Rhön”

Dear Mr. District Chief Executive Heimrich,

the non-profit and sponsoring association of the Hessian part of Rhön Biosphere Reserve, the Verein Natur- und Lebensraum Rhön, supports the application to become an IDA Dark Sky Reserve.

We recommend this project and see great development potential in its realization – within the realms of protecting nature and species as well as within the realms of regional development and tourism.

With regard to the planned energy transition in Germany we appreciate this project, as it promotes saving energy and an improved usage of energy in an emotional way.

Consequentially, the Verein Natur- und Lebensraum Rhön has been involved in the project right from its beginning in 2011 and commits itself to give strong support for its further steps of realization.

With kind regards,
Martin Kremer
Managing Director



Vorsitzender
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Befürwortung und Unterstützung des Projektes „Sternenpark im Biosphärenreservat Rhön“

„Veraltete Stadtbeleuchtung verschwendet nicht nur Energie und Geld, sondern heizt auch das Klima auf und schadet der Natur.“ Mit diesem Satz beginnt eine Informationsschrift des NABU-Bundesverbandes* aus dem Jahr 2009, die sich mit dem Verlust der Nacht, der Lichtverschmutzung, der Energieeffizienz und dem Klimaschutz, sowie der Insektenverträglichkeit und dem Naturschutz auseinandersetzt. Auf dieser Basis wurden bundesweit in großen Kommunen Veranstaltungen zur Modernisierung der Stadtbeleuchtung durchgeführt.

In der Region Osthessen hat der NABU-Kreisverband Fulda bereits 1996 die Initiative ergriffen und zusammen mit der damaligen ÜWAG eine Informationsschrift zu diesem Thema herausgegeben.** Die Herausgeber kamen damals mit Zuständigen der Stadt Fulda überein, künftig mehr Natriumdampf-Hochdrucklampen anstatt Quecksilberlampen zu verwenden. Dies entsprach dem damaligen Stand der Technik.

Dieser Vorlauf zeigt, dass der NABU die Bedeutung der Lichtverschmutzung und die Wichtigkeit des Schutzes der Nacht für den Umwelt- und Naturschutz bereits lange erkannt hat und daher wird das Projekt „Sternenpark im Biosphärenreservat Rhön“ von Beginn an begrüßt und unterstützt. Dieses Projekt hat in den letzten Jahren außerordentlich viel zur Information der Bürgerinnen und Bürger, zu Entscheidungshilfen für Mandatsträger und auch bereits zu praktischen Konsequenzen beigetragen.

Der NABU-Kreisverband Fulda ist mit rund 2700 Mitgliedern der größte Naturschutzverband in Stadt und Kreis Fulda. Bundesweit ist der NABU mit rund 540.000 Mitgliedern und hessenweit mit rund 50.000 Mitgliedern der größte Umwelt- und Naturschutzverband.

Der NABU-Kreisverband Fulda befürwortet außerordentlich die Einrichtung eines „Sternenpark“ in der Rhön und ist zu weiterer Zusammenarbeit gerne bereit.

Mit freundlichen Grüßen!
29.04.2014

Volker Strauch
1. Vorsitzender
NABU-Kreisverband Fulda

*
<http://www.nabu.de/themen/energie/stadtbeleuchtung/>
NABU-Info (2011): Kommunale Lichtplanung für eine energieeffiziente und ökologisch verträgliche Stadtbeleuchtung. Einführung und Überblick zu den NABU-Arbeitshilfen für Kommunen, Energiedienstleister sowie Planungs- und Ingenieurbüros.

**
Richtig belichtet! Die Straßenbeleuchtung unter ökologischen und ökonomischen Gesichtspunkten, NABU-Kreisverband Fulda und ÜWAG, 1996, 24 Seiten.

Translation:

Naturschutzbund Deutschland (NABU)

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Endorsement and Support of the Project "Dark Sky Reserve within the Rhön Biosphere Reserve"

"Outdated technology in city lighting not only wastes energy and money but also heats up climate change". This is the introductory sentence of a information brochure of the federal association of the NABU Germany from 2009, which deals with the loss of the night, light pollution, energy efficiency and climate protection as well as compatibility for insects and nature protection. On this basis, events on modernizing city lighting were conduct in bigger municipalities nationwide.

In the region of Eastern Hesse we already took the initiative in 1996 and published an information leaflet together with the local electricity supplier ÜWAG (translator's note: today RhönEnergie Fulda). The authors came to an agreement with the town of Fulda, to use more high pressure sodium lamps instead of mercury vapor lamps. This was conforming to the state of technique at the time.

This shows, that the NABU has already recognized the significance of light pollution and the importance of the protection of the night for environmental and nature protection a long time ago and against this backdrop we have welcomed and have supported the project "Dark Sky Reserve within the Rhön Biosphere Reserve" right from the beginning. In the last couple of years, this project has contributed a great deal in informing citizens, has aided elected representatives to decision making and has already shown consequences.

With about 2700 members, the district association of the NABU is the biggest nature protection association in the county of Fulda. Germany wide, the NABU counts 540.000 members and in Hesse about 50.000, which means, that the NABU is the biggest nature protection association.


The NABU district association strongly supports the establishment of a Dark Sky Reserve in the Rhön and is willing to further cooperate.

Kind regards,
29.04.2014

Volker Strauch
Chairman
NABU District Association of Fulda



VEREIN FÜR NATURKUNDE IN OSTHESSEN E. V.

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18 250 66065

16.05.2014

Sehr geehrte Damen und Herren,

der Verein für Naturkunde in Osthessen e.V. unterstützt die Bemühungen der Einrichtung eines Sterneparks im Biosphärenreservat Rhön.

Der VNO ist ein Zusammenschluss von naturkundlich interessierten Personen, die sich im osthessischen Raum den Themenfeldern Astronomie, Botanik, Ornithologie und Geologie widmen. Auf unserer Homepage (www.vno-fulda.de) können Sie das ganze Spektrum unserer Aktivitäten und unseres Wirkungsbereiches nachlesen.

Mit großem Interesse und auch und mit eigenen Anstrengungen verfolgt der VNO die Bemühungen um die Wahrung der natürlichen Nachtlanschaften der Rhön. Wir sehen den Schutz des nachtaktiven Lebensraumes als wichtigen und zukunftsweisenden Teil der Naturkunde und Naturschutzarbeit an.

Insbesondere die eigens aufgestellten und bereits von vielen Kommunen durch politischen Beschluss angenommenen Beleuchtungsrichtlinien machen Hoffnung, dass dieses Thema kein Strohfeuer, sondern auf Dauerhaftigkeit angelegt ist.

Durch unseren Fachbereich „Astronomie“ sehen wir in einer Anerkennung der Rhön als Sternenpark einen Schlüssel für die Wiederentdeckung der Nacht als Kulturgut.

Die Bewerbung des Biosphärenreservates Rhön auf den Titel „Sternenpark“ hat daher unsere volle Unterstützung.

Mit freundlichen Grüßen



Jörg Burkard

1. Vorsitzender des VNO

Translation VNO

Fulda, 16.05.2014

Dear Madam or Sir,

the registered association for natural study and history in Osthessen (VNO) supports the efforts for establishing a Dark Sky Park within the Biosphere Rhön.

The VNO is a consortium of people, who are interested in natural study -particularly in the fields of astronomy, botany, ornithology and geology. You can view the spectrum of our activities on our website www.vno-fulda.de.

With great interest and efforts of our own, we pursue all endeavors for the safeguarding of the existing natural nightscapes of the Rhön. From our perspective, the protection of the nocturnal habitats is an important and forward looking part of natural studies and nature protection work.

Especially the guidelines, developed for this project and already accepted by many communities via political decision give us hope, that this topic follows a long-term strategy and is not just a flash in the pan.

Also, via our faculty of astronomy we see in a designation of the Rhön a key for the re-discovery of the sky as a cultural good.

The application of the Biosphere Rhön to become a “Sternenpark” is fully supported by us.

Kind regards,

Jörg Burkhard
Chairman VNO

Thüringer Ministerium für Landwirtschaft, Forsten, Umwelt und Naturschutz -
Postfach 90 03 65 - 99106 Erfurt

International Dark Sky Association
3223 N. First Avenue
Tucson, Arizona 85719
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**Support of the project of International Dark Sky Reserve in the
Rhoen UNESCO Biosphere Reserve**

**Ladies and Gentlemen,
IDA board members,**

As the Thuringian Minister of Agriculture, Forestry, Environment and Nature Protection I am, together with my colleagues in Hesse and Bavaria, responsible for the protection and development of the Rhoen UNESCO Biosphere Reserve (BR).

The Rhoen Biosphere Reserve was recognized by UNESCO in 1991. Since this time the three Federal States have been proud of their BR and we are equally proud of all our activities in this area.

We have provided a great deal of money for several projects to protect the landscape, its flora, fauna and human inhabitants alike. We have already given and are willing to continue to provide money in future for the ongoing process of developing the Rhoen BR as a model region for sustainable development.

We had our second evaluation by UNESCO last year and we are still waiting for the feedback from Paris.

I am happy about and proud of the new projects in our Rhoen BR.

On behalf of my colleagues in Hesse and Bavaria, I also support the application for the conferring on parts of the BR Dark Sky Reserve status in the Rhoen Biosphere Reserve.

Yours truly,


Jürgen Reinholz

Thuringian Minister of Agriculture, Forestry, Environment and Nature Protection

Der Minister

Jürgen Reinholz

Durchwahl:
Telefon 0361 3799-901
Telefax 0361 3799-950

juergen.reinholz@
tmf.mf.thueringen.de

Ihr Zeichen:

Ihre Nachricht vom:

Unser Zeichen:
(bitte bei Antwort angeben)
54-44125.17

Erfurt
May ..., 2014

Thüringer Ministerium für
Landwirtschaft, Forsten,
Umwelt und Naturschutz
Beethovenstraße 3
99096 Erfurt

www.thueringen.de

Verkehrsverbindungen:
Zu erreichen mit den
Straßenbahnlinien 1 (Landtag),
3 und 4 (Tschairowskistraße)



BISCHÖFLICHES GENERALVIKARIAT • Postfach 11 53 • 36001 Fulda

BISTUM FULDA

Landkreis Fulda
Projektkoordination Sternenpark
Frau Sabine Frank
Gallasiniring 30
36043 Fulda

DER
GENERALVIKAR

Sehr geehrte Frau Frank,

Teile des Biosphärenreservates Rhön gehören zum Gebiet des Bistums Fulda. Gerne unterstützt das Bistum Fulda deshalb die Bemühungen der Einrichtung eines Sternenparks im Biosphärenreservat Rhön. Denn in der biblischen Schöpfungsgeschichte heißt es:

„Lichter sollen am Himmelsgewölbe sein, um Tag und Nacht zu scheiden. Sie sollen Zeichen sein und zur Bestimmung von Festzeiten, von Tagen und Jahren dienen; sie sollen Lichter am Himmelsgewölbe sein, die über die Erde hin leuchten. So geschah es. Gott machte die beiden großen Lichter, das größere, das über den Tag herrscht, das kleinere, das über die Nacht herrscht, auch die Sterne. Gott setzte die Lichter an das Himmelsgewölbe, damit sie über die Erde hin leuchten, über Tag und Nacht herrschen und das Licht von der Finsternis scheiden. Gott sah, dass es gut war.“ (Gen 1, 14-18)

Sehr ausführlich geht dieser, wohl rund 3000 Jahre alte, Text auf Sonne, Mond und Sterne ein, auf Licht und Dunkel, auf existentielle Erfahrungen aller Menschen. Der Erhalt dieser Gott gegebenen Ordnung von Tag und Nacht ist uns als Christen ein wichtiges Anliegen. Denn der Mensch und sein innerer Biorhythmus sind daran angepasst. Auch die Lebensrhythmen der Menschen und der Gesellschaft erfahren durch Tag und Nacht ihre Gliederung. Der Wechsel von Aktivität und Ruhe, von Arbeit, Schlaf und Freizeit sind wesentlich für das körperliche und auch für das seelische Wohlbefinden.

In Großstädten mit nächtlichem Kunstlicht lassen sich Licht und Dunkel fast nicht mehr erleben. Unser Schöpfer hat die Menschen mit der Fähigkeit ausgestattet, natürliche Zeiten und Räume radikal umzugestalten. Ist das eine kreative Distanzierung von seiner Schöpfung

Paulustor 5
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Telefon:
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Datum:
Juli 2014

Ihre Nachricht / Ihr Zeichen:

BearbeiterIn:
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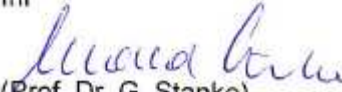
oder ist es in ihr angelegte, natürliche Entwicklung? Dieser Frage müssen wir uns stellen, nicht zuletzt weil wir für Tiere und Pflanzen, für den gewachsenen Naturraum mit unseren Fähigkeiten Verantwortung übernehmen.

Nicht nur der Mensch, sondern auch die gesamte Schöpfung mit ihrer wunderbaren Vielzahl der Arten (Biodiversität) ist an den Tag oder die Nacht sowie an den kontinuierlichen Wechsel von Licht und Dunkel angepasst. Deshalb ist es gut, wenn es für Mensch und Tier Rückzugsräume gibt, wo Tag und Nacht noch Leben und Rekreation in diesem Rhythmus erlauben. Kirchliche Gebäude gewähren Unterschlupf für zahlreiche, z. T. auch nachtaktive Tiere. Oft bieten die Kirchengemeinden aktive Hilfestellungen, wie z.B. Nistkästen im Kirchturm, gerade auch für Eulen. Um diese Maßnahmen zu intensivieren, wirkte die Umweltbeauftragte des Bistums Fulda an diversen aktuellen Publikationen und kirchlichen Schriften sowie Bildungsangeboten maßgeblich mit. Die ökumenisch verfasste Handreichung „Biodiversität und Kirchen – eine Empfehlung der kirchlichen Umweltbeauftragten“ wurde allen Kirchengemeinden im Bistum Fulda überreicht.

Wir unterstützen unsere katholischen Kirchengemeinden bei ihren Bemühungen, mit Energie so sparsam wie möglich umzugehen. Schon aus diesem Grunde empfehlen wir, falls das Anstrahlen von kirchlichen Gebäuden praktiziert werden sollte, dies auf den Zeitraum bis 22 Uhr zu begrenzen. Für solche Strahler gibt es vom Bistum keine finanzielle Unterstützung. Das Bistum Fulda bietet regelmäßig bei den Energiesparwochen der Stadt Fulda Akademieabende zum Energiesparen in Kirchengemeinden und zum nachhaltigen Bauen an. Die Kirchengemeinden werden durch fachliche Beratung und durch ein Energiemanagementsystem zum Energiesparen angeleitet. Zukünftig werden wir auch noch intensiver darauf achten, dass Außenbeleuchtungen, sofern vorhanden, optimal justiert und auf ein Minimum reduziert werden.

Mit freundlichen Grüßen

Ihr


(Prof. Dr. G. Stanke)
Generalvikar

July 2014

Translation of the letter of the Vicar-general of the diocese Fulda

Dear Ms Frank,

Parts of the Biosphere Reserve Rhön belong to the territory of the diocese of Fulda. The diocese Fulda is happy to support the efforts to set up a *Sternenpark* in the Biosphere Reserve Rhön. In the biblical genesis it already says:

“And God said, “Let there be lights in the vault of the sky to separate the day from the night, and let them serve as signs to mark sacred times, and days and years, and let them be lights in the vault of the sky to give light on the earth.” And it was so. God made two great lights-the greater light to govern the day and the lesser light to govern the night. He also made the stars. God set them in the vault of the sky to give light on the earth, to govern the day and the night, and to separate light from darkness. And God saw that it was good.” (Gen 1, 14-18 - New International Version)

This text, probably 3000 years old, goes in great detail about the sun, the moon and the stars – on light and shade and on the existential experience of all humans. The preservation of this order of day and night as given by god is an important concern to us Christians. Because the inner biorhythm of humans are adjusted to it. Also, the rhythms of human life and of society experience their structure by day and night. The change of activity and quietness, of work, sleep and leisure time are essential for the bodily and mental well-being.

In large cities with their artificial light at night there is almost no chance to experience light **and** dark. Our maker has equipped humans with the ability to radically redesign natural times and rooms. Is this a creative alienation from his creation or is it an intrinsic and natural development? This is the question we have to ask ourselves, not least because we are responsible for animals and plants and the natural area.

Not only humans, but also the whole creation with its wonderful variety of types (biodiversity) is adapted to either the day or the night as well as to a continuing change of light and dark. Bearing this in mind, it is very important for humans and animals to have areas which allow day and night and recreation in this rhythm. Buildings of the church provide a safe haven for many animals, e.g. nocturnal animals. Quite often members of the parish help actively; e.g. nesting boxes for owls in the church towers. In order to intensify these measurements our environmental officer is involved in diverse current publications and developing training sessions. The ecumenical composed handout “Biodiversity and the Church – a recommendation of the clerical environmental officer” was given out to all parishes in the diocese of Fulda.

We support our catholic parishes in their efforts to use energy as economically as possible. For this reason we recommend – if illuminating the clerical buildings at all – to limit this to 10 p.m. The diocese of Fulda doesn't offer any funding for these spotlights. The diocese of Fulda offers on a regular basis information events on how to save energy and how to build sustainable – together with the city of Fulda. The parishes are also guided by expert advice and a energy management system.

In the future we will more intensively see to it that – if there is outside lighting – it is optimally adjusted and reduced to a minimum.

With kind regards,

Yours,

(Prof. Dr. G. Stanke)
Vicar-general

Statements from people living in or visiting the Rhön:

These statements are from people engaged in astronomy or nature protection.

In August 2013 I led a telescope making workshop at the Astronomical Summercamp (ASL) near Bischofsheim / Rhön. (Website: <http://www.vega-astro.de>) The place is chosen for its exceptionally dark sky though being in good reach for most participants in the center of Germany. We had clear skies and observed many deep sky objects with my 24-inch Dobsonian telescope, see <http://www.vega-astro.de/node/179>. For most of the young potential scientists this was the first time in their life, to see spiral structure in galaxies and fine detail in diffuse and planetary nebulae with their own eyes. Please reserve the dark skies at his place for future generations!

Stathis Kafalis, Munich

Practising deepsky photography since 30 years under the dark skies of the rural Rhön district of Germany, I am still stunned by its breath-taking beauty.

I think it is really worthy to be protected as a darksky reserve.

Jens Mueller, Hofbieber

In 2012 I was observing the night sky together with the commission (note: commission of experts for school astronomy of the federal state of Thuringia) on the grounds of the Geba Mountain. Hardly ever have I had such an impressive night of observation before. Unfortunately, in Thuringia there are only a few places left without light pollution. Close to the village von Rohr/Meiningen I have also found very good conditions for observation. Its central location in Germany would surely be very favourable for installing a permanent observation location in order to lead hobby astronomers as well as school groups to the secrets of the night sky. Furthermore, the installation of a permanent location at this place would be beneficial for seminars about observation and teacher training. I wish you all the best for all your efforts.

Gerburg Unger, Apolda

My name is Andrea Scholze. Astronomy is my hobby which I am very passionate about next to job and family. My home is in the Thuringia part of the Rhön and I live in the village of Kaltenwestheim. With my telescope AC 127/1200 and my binoculars I have already had wonderful strolls in the night sky. When I step at night onto my patio, a fantastic and stunning firmament opens up to me and the stars twinkle in my direction and invite for linger and marvel.

The Rhön is home of many villages. Because of its rurality and sensitive landscape, there is almost no industry. One would be searching for high-rise buildings in vain. Very disturbing light sources, which send star gazers into despair, are hence in the Rhön not existing.

The night sky is dark, the Milky Way is very good visible with the naked eye. Star clusters, i.e. h and chi Persei or M44 or even Andromeda Galaxy M31 (by watching indirectly) are visible without any tools. Using a telescope or binoculars offer the observer an even more intensive sight of sky objects, which for example inspires for drawing. I also like watching planets and emission nebulae with my telescope.

The dark skies of the Rhön are worth to be protected. If the Rhön gets acknowledged as an International Dark Sky Reserve, it would just be right in my eyes. Lots of locals appreciate "their" Rhöner sky and to preserve this is a worthy aim.

Andrea Scholze, Kaltenwestheim

The Institution for Environmental Education Oberelsbach supports the efforts for a Dark Sky Reserve in the Rhön. For our guests we offer star walks, which are always a great experience for all ages. Sometimes in cloudy nights it's only a walk in the dark without torches or flashlights, which is very new to many pupils. And with clear sky everyone is touched by the stars, the Milky Way and occasional falling stars. We are using iPods with the star-walk-app for orientation and spyglasses for special observations like the moon or the Pleiades. We are looking forward to Dark Sky Reserve Rhön to improve our star walks.

Joachim Schneider, trainer for education for sustainable development Umweltbildungsstätte Oberelsbach

I worked with my astronomy course from the 30th of January to the 1st of February, 2014, in the facilities of the Rhöniversum, because the Long Rhön is one of the highest and darkest places in the middle of Germany.

Beyond it, the light pollution or light smog is extremely low, so that a nearly natural night sky exists, what has been confirmed meanwhile also by measurements ($m = 21.7$). We observed the winter hexagon with the Great Orion Nebula, the Plejades and Hyades, also well-chosen stars and the planet Jupiter.

Fortunately, the day hours can be used very well with the programs from the "Thüringer Hütte" or the "Umweltbildungszentrum Oberelsbach", also instructive wanderings can be carried out. For these reasons I absolutely recommend to expel the Rhön as a dark sky park. If you have any further questions, please do not hesitate to contact me.

Kind regards

Heinz Reiser, head of physics dept. Gymnasium Miltenberg

The summer Milky Way above the Rhön Mountains is so impressive, that I took my last vacations in this region only to take some photos of it.

Manfred Bruer, Bremerhaven

My name is Mathias Sawo from Erfurt and I discovered astronomy as hobby one year ago. In particular, I find the visual observation of deep sky objects with a telescope particular appealing. Living in a town, I soon realised that I need a dark sky for my hobby. After having done some research und getting hints from other hobby astronomers I came across the Rhön, which was said to be a very dark place. Ever since is the Rhön and the mountain of the Hohe Geba my main location for observation. The dark sky in conjunction with its height result in a wonderfully transparent sky that is so important for the faint objects I like to observe. Furthermore, the Rhön is very popular with other friends of the nature which I sometimes meet at night and who are fascinated when watching through my telescope. As I am still quite young I hope to be able to practice my hobby for a long time. But at the same time I am worried about the raise of light pollution. I would madly appreciate it, if such a place in the future would be protected by becoming a dark sky park. The Rhön and its central location would also be worth a trip for people living in other parts of the country. Not only today's hobby astronomers would be very happy about a decision to become a dark sky park but also the rich wildlife as well. Thank you.

Mathias Sawo, Erfurt

In my opinion, the Rhön should be disclosed as a Dark Sky Park, as the Rhön is one of the few places in Germany with an almost natural night sky. One can even watch the Milky Way in winter and the vision of many stars is unique in Germany. I have been observing the night sky for almost 30 years and I am always disappointed how much the sky is polluted in other regions – even outside industrial regions and even nations.

I usually observe the night sky in my hometown of Utrichshausen, right on the border to the Rhön. Whenever time allows I drive into the direction of the Schwarzes Moor, as there is almost no annoying light. I know a lot of hobby astronomers which pay a lot of money for a trip to Namibia in order to observe and experience a natural night sky. This we can have in the Rhön as well by protection our cultural good of a natural night sky by becoming a "Sternenpark Rhön" and also by making it accessible to many people.

Stefan Brähler, Utrichshausen

Being a master electrician, I supply the communities with luminaires. Not long ago a rep from a big company came to show me some new models. When he entered to room, he said: "I know, here in the Rhön you only want full cut-off and 3000 K." This shows, how much the topic of avoiding light pollution has arrived here in the Rhön. This is something you can be very proud of.

Alfons Fuß, ÜWR Bischofsheim

Dear Sabine,

the project of Sternenpark Rhön deserves number one priority and implementation for the following reasons: This projects fits into implementing the turnaround in energy policy in relation to the problems of wind turbines, new electricity links and saving energy. Moreover, the protection of our grey moth is indispensable as these animals fly around non-insect-friendly luminaires until they are totally exhausted and die. More than 14 billion insects die at nights – countless more come to death by collisions with cars. Other than that, is protection the night also protection humans, as the nights become more and more days and disturb the human biorhythms. Therefore we do need protection zones and good practice examples in towns and villages in order to sensitize politics and society on all levels. The argument of security from criminals has been disproved via a study carried out in London. Please keep dedicated to your commitment. You can always count on my and our (HGON) support. - Good luck!

Reinhard Kolb, Hessische Gesellschaft für Ornithologie und Naturschutz (Hessian Ass. for ornithology and nature protection)

I support the project Dark Sky Park. Every night I have to walk to work. Everywhere is lighting. Solutions using motion detectors, which save energy and reduce light pollution, already exist. More over, lighting up whole valleys by using floodlights is questionable. On sport grounds it won't be darker, if you limit the light by using flaps.

Mario Fladung

Being a hobby astronomer one must ascertain, that the brightness of the sky regrettably is increasing. It is very important – also in terms of nature protection for nocturnal animals – to analyse our behaviour as a modern society and – similar to other areas of protecting the environment – do reduce these disturbances and create and protect "biotopes". Your work for the project Dark Sky Park Rhön is exemplary for the whole of middle Germany and to my knowledge unique. I wish you all the needed support....

Georg Beringer

As a central landscape in Europe with extremely low traffic, settlement and light-pollution, the Rhön seems to me the ideal region to be preserved as a dark sky reserve. I hope, that it will be possible to use these features to give visitors insight in the impressive aspect of the undisturbed firmament, and to give amateur-astronomers facilities to conduct their hobby in undisturbed areas.

Dr. med. Reinhard Zerzawy; Schlüchtern

When all lights are switched off in the planetarium and only the artificial starry sky is visible under the dome, one realizes the amazement of the visitors. This amazement should be felt under the real starry sky – but where are the lights switched off?

Gerd Habersack, Planetarium im Vonderau Museum Fulda

The establishment of a star park would be very reasonable because the observation of the night sky – especially the stars, planets and Messier-objects and so on – is hardly possible in lit up towns and villages in the region. The Geba Mountain offers good observation conditions. This is well known and used amongst many hobby astronomers. The establishment of a star park would promote an improvement of the observing situation. The Geba Mountain is easy to reach – it only takes 25 min from the motorway A71, exit Meiningen North.

At the astronomical observatory of Meiningen, a group of interested observers is willing in parenting or even run events up on the mountain Geba. There is a high interest in astronomical observation in this region. This is proven by the number of participants at the monthly astronomical lectures, which after reopening take place at the observatory. The Henfling-Gymnasium (remark translator: high school) offers its own astronomy profile: astronomy / astrophysics lessons from grade 9 up to grade 13. This is unique in Germany.

Wolfgang Fiedler, Sternwarte/Observatorium Meiningen

The goal of our society is the education in Astronomy and Astrophysics and spread this knowledge to interested public parties as well as in school education. Our major practical parts are the observation of the night sky and the astrophotography of deep sky objects. Especially for deep sky observation an unpolluted sky is necessary.

The Rhön Biosphere Reserve has the potential to preserve the Natural Night Sky as our cultural good. We are sure that it is the correct measure and a significant step forward when the Rhön Biosphere Reserve gets the status of a "Dark Sky Park".

Our Astronomical Society will strongly support and enjoy the Dark Sky Park at the Rhön Biosphere Reserve.

Werner Klug, Astronomical Society Freigerecht

Letters of Support: IDA-Members

Support letter by Sabine Frank

Initiative zum Schutz der Nacht | vor Ort

Informationen zu Auswirkungen und Vermeidung von
Lichtverschmutzung | Nachtwanderungen



Initiative zum Schutz der Nacht vor Ort - An der Röhre 8 - 36145 Hofbieber

Erst was der Mensch zu schätzen lernt,
ist er bereit zu schützen.

International Dark Sky Association
3223 N. First Avenue
Tucson, Arizona 85179
USA



Hofbieber, 15.05.2014

Dear Board Members,

When, in 2009, I first read about the concept of dark Sky Parks in the nationwide Magazine DER SPIEGEL I was initially sparked up to this idea, as I already had offered popular star guiding tours to the general public for a couple of years and had noticed, that the sky towards the town of Fulda got brighter every year due to the expansion of an industrial estate outside town. At the same time I could easily see the Andromeda galaxy, the bee hive and M13 and therefore knew about the magnificence of the Rhöner night sky. So, having heard about dark sky parks, knowing the marvel of the Rhöner night sky and also realizing a possible loss through ignorance and as a keen nature conservationist, I got started. My first attempt failed miserably, as I sent the SPIEGEL article and an accompanying letter to the mayor of my resident town. They had never heard of light pollution or it's implications on nature and probably thought it was a joke.



Nevertheless, one year later in the course of my studies at Fulda University I was able to pick up the topic again. Together with some fellow students we started the theoretical project "Dark sky park in the Biosphere Reserve Rhön" by comparing aims and tasks of the UNESCO program Men and Biosphere with those of IDA Dark Sky Program and interviewing Dr. Andreas Hänel over the phone.

After finishing my studies of social and cultural studies I sent the student's work to the Hessian administrative office of the Biosphere Rhön. Being quite persisting, it got finally looked at and the students group was invited to present the project. After that they asked, whether the Rhön would have the potential for becoming a Dark Sky Reserve in reality.

So, the next step was taking SQM measurements. For this, Dr. Hänel visited for the first time the Rhön during new moon in March 2011. Luckily, the Rhöner night sky was gracious and offered perfect conditions for observation and measurements. That night already we measured up to 21.78 mag/ arcsec. Me being new to this measuring business I was very happy. We drove around for many nights more and presented our first report to the persons at charge at the Biosphere administration.

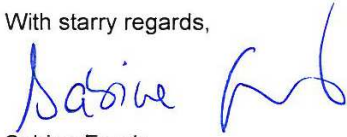


After this presentation, the topic of light pollution and the establishment of a dark sky park within the Rhön took off like a rocket. A flyer got printed, the private "Initiative to Protect the Night Sky" was founded, we had a booth on the festivities 20 years Biosphere Rhön and reached many people. Suddenly, by the ARGE Rhön taking on the project, the topic of protecting the nights of the Rhön was all over the papers and media.

In the course of fighting for the protection of the night sky, the implications of artificial light at night to animals and plants have become my strongest motivation – next to my big love to watch the stars and offering moon guiding tours.

Now the topic of light pollution has arrived and settled in the Rhön. Endless lectures on light pollution, the lighting management plan, star guiding tours, interviews, talks and building up a good relationship with the local suppliers of Energy, who advice the municipalities and sell "light", and a lot of ' against the odds' have led to this fact. Now it is time for the Rhön to get awarded for all the work already being done and also, in order to reach a sustainable and long term protection of the night and all beings in it. This is what I stand and fight for and offer my full support – now and in the future.

With starry regards,



Sabine Frank



Support letter by Harld Bardenhagen

Harald Bardenhagen
Astronomie-Werkstatt
„Sterne ohne Grenzen“
Sülgürtel 42
50937 Köln
GERMANY



Monday 19 May 2014

✉ haraldba@sterne-ohne-grenzen.de

Rhön Biosphere Reserve Application for International Dark Sky Reserve Certification

Dear IDA Board of Directors!

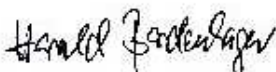
This letter is offered in very strong support of Rhön Biosphere Reserve application for International Dark Sky Reserve status. Being one of the few IDA members in Germany I am pleased to confirm not only the famous night sky quality of the Rhön Biosphere Reserve but also the awesome support for a Dark Sky Park within the region and their people.

I had the opportunity to spend two weekends under an impressive starry night sky and took part in one event for lighting specialists and decision makers of the region. I was very impressed not only by the impressive dark skies I was able to enjoy but also about the successful efforts of persuasion which already were achieved by the regional project coordination of "Sternenpark im Biosphärenreservat Rhön" – Mrs. Sabine Frank – and the scientific chaperonage of the project by Dr. Andreas Hänel.

Just mention one result: RhönENERGIE Fulda, an important regional supplier and service provider for power feeding and lighting consulting and management, strongly supports blue-low and blue-less artificial light at night.

I watched with interest how intense the subject-matter "Starry Night Sky over Rhön Biosphere Reserve" already reached the hearts of the people in the region. Successes in tourism business have become apparent already: the host of the hostelry "Kissinger Hütte" told me about an enormous increase of over-weekend-guests during the last two years. Amateur astronomers from nearby cities like Fulda swamped the parking lot of the lodging house and also its rooms.

I am dead certain that the designation of Rhön Biosphere Reserve as an IDA Dark Sky Reserve will lead to night sky friendly approach to outdoor lighting and will be an inspiring example for other regions in Germany.



Harald Bardenhagen



International Dark-Sky Association

International Headquarters
IDA Board of Directors
3223 N. First Avenue
Tucson, Arizona 85719
USA

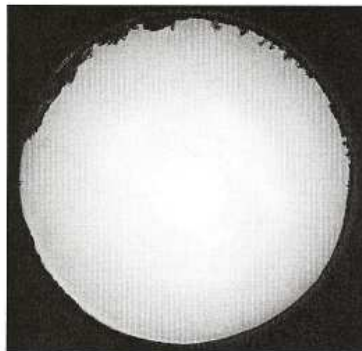
Ljubljana, May 12, 2014

**Biosphere Reserve Rhön as Dark-Sky Reserve – Nomination –
A Letter of Support**

Dear IDA Board of Directors,

as a member of Dark-Sky Slovenia I declare our support for the nomination of the Biosphere Reserve Rhön for an IDA International Dark Sky Park designation and the efforts of the Reserve to preserve the night sky.

I visited Biosphere Reserve Rhön on October 10, 2011. Unfortunately it was cloudy weather that day. I spend part of the night driving in the reserve and I found it very dark. There were no settlements in a large area. The only lights that were disturbing were more than 50 km away from Reserve and this is incredibly large distance for highly populated Germany. I took fisheye image with the same settings as I use for 22 magnitude sky (see image below).



It is amazing that there is no orange ring on that image. In case of clouds such orange ring caused by HPS luminaires would be even enhanced. This is a confirmation that site is very dark and it should be preserved.

Between 1997 and 2007 I drove many times in the night on highway west of the Biosphere Reserve Rhön on relation from Fulda to Kassel. Even from my car I found out that this part of Germany is comparably darker than other regions. At that time I had no idea that nearby Biosphere Reserve Rhön is one of the darkest places in Germany.

The application for a protected area in the central part of Germany is challenging: large cities, industrial areas, highways traffic and greenhouses are the cause of light pollution even in remote sites. However: the initiative in Rhön region has a vision to protect the starry night sky and the natural nightscape well beyond the borders of the Reserve.

The area has sky brightness darker than 21.50 magnitude in zenith, which is very rare in Europe. So it is necessary to be protected as soon as possible.

The main local power behind activities for protection is Ms. Sabine Frank. She is the best woman I know in the field of fight against light pollution with great results in very convincing communication with local people. Her activities and activities of other environmentalist and astronomers in the region include guided tours and regular observations. This is of enormous importance for protection of Reserve.

I am confident that honoring the Biosphere Reserve Rhön as an IDA Dark-Sky Reserve will have an impact well beyond the borders of the Reserve.

Best regards,

Dark-Sky Slovenia

Andrej Mohar



5 Rhön UNESCO Biosphere Reserve

5.1 Nature Protected Areas in Germany

In the following the system of protected areas in Germany will be presented in order to clarify the framework **conditions for environmental protection**.

Three different categories of large-scale conservation areas are designated in Germany which could potentially also protect dark night landscapes (or nightscapes) (more information on www.bfn.de, English version).

1 National Parks (Nationalparke)

The 14 national parks cover 0.55% of the area of Germany and are areas which show little or no impact by human interaction. Very strict rules apply to protect nature and biodiversity, they are free of human exploitation or intervention.

2 Biosphere Reserves (Biosphärenreservate)

16 UNESCO Biosphere Reserves cover 3.6% of the national area and preserve, develop or restore landscapes shaped by traditional diverse uses. Research and education play a central role and they are model regions for a sustainable development. An important concept to reach these goals is the use of zones of different protection levels: core, buffer and development zones.

3 Nature Parks (Naturparke)

101 nature parks cover 26% of the area of the country. They are large-scale mainly landscape protected and nature conservation areas that are intended for recreational purposes and sustainable tourism. The aim is to protect and conserve cultural landscapes with their diverse species and habitats through sustainable use of land and for purposes of recreation and nature-friendly tourism. Therefore protecting the nightscape using a sustainable artificial lighting could be one topic in the future development of nature parks.

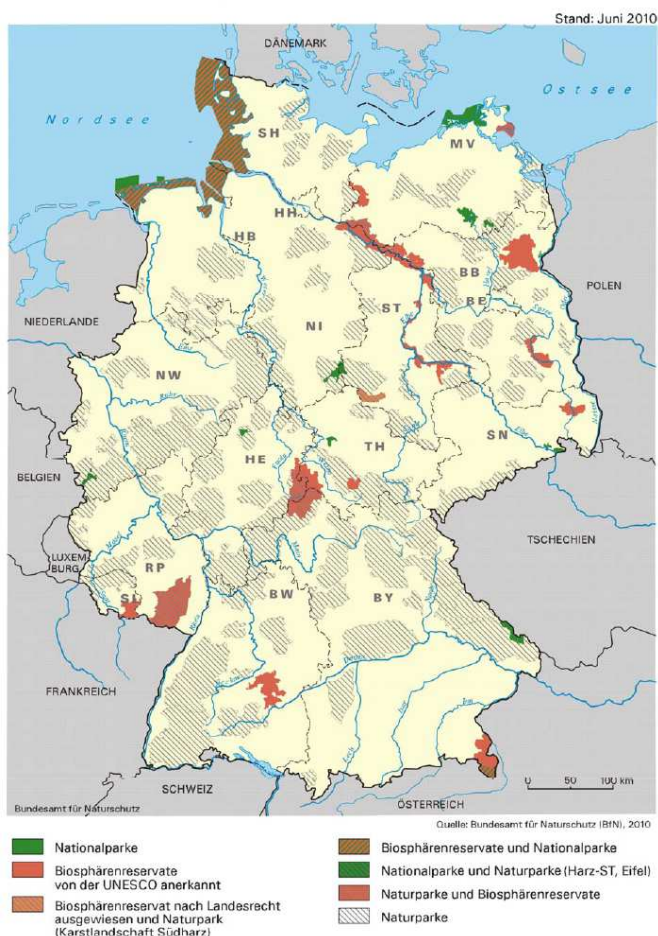


Fig. 5.1: Nature protected areas (green: national parks, red/brown: biosphere reserves, hashed black: nature parks) in Germany (BfN).

The German Federal Agency for Nature Conservation (Bundesamt für Naturschutz – BfN) is the federal government’s scientific authority responsible for national and international questions of nature conservation. The protection of the nightscape was an important aim of the agency as they had already published in 2001 papers of a workshop on the influence of artificial lighting on animals in nature (Böttcher ed., 2001).

In 2013 the agency published the proceedings “Protecting the night – Schutz der Nacht” as a result of an interdisciplinary conference in Tutzing, which shows that the protection of the night is getting more and more recognized in German nature protection schemes. The proceedings cover a large variety of themes on all aspects concerning artificial light at night and became therefore a reference publication in German language (Held et al., 2013). In the preface the president of the BfN, Prof. Dr. *Beate Jessel*, supports the necessity of protecting the night. A follow-up conference is planned for November 2014.



Fig. 5.2: Full moon over the Rhön

5.2 Some Key Data of the Biosphere Reserve

Founded:	1991 distributed over 3 federal states (Thuringia, Hesse, Bavaria)
Coordinates:	latitude: N 50.21° - 50.88°, longitude E 9.73° - 10.355°
Area:	1.865 km ² with: » core zone 64 km ² (3.4%) » buffer zone (Pflegezone) 494 km ² (26.5%) » development zone (Entwicklungszone) forest 40.3% greenland 31.5% agriculture 18.4% settlements 3.8 %
Nature Protected Area:	147 km ² = 8%
Natura 2000 - FFH	469 km ² = 25%
Landscape Protected Area:	856 km ² = 46 %
Star Park	Core zones E0: 145 km ² Buffer zone E1: 874 km ²
Communities:	162.000 inhabitants in 40 communities
Population Density:	88 inhabitants/km ²
Board of Trustees:	Regionale Arbeitsgemeinschaft Rhön (ARGE Rhön), representatives of 5 counties (Landkreise): <ul style="list-style-type: none">• Landkreis Fulda• Wartburgkreis• Landkreis Schmalkalden-Meiningen• Landkreis Rhön-Grabfeld• Landkreis Bad Kissingen
Administration:	Biosphärenreservatsverwaltungen Bayern, Hessen, Thüringen
Total staff:	30
Biosphere Reserve Visitor Centers:	Haus der Schwarzen Berge, Oberbach Haus der Langen Rhön, Oberelsbach Groenhoff-Haus Wasserkuppe, Gersfeld Probstei Zella, Zella Point Alpha, Rasdorf Umweltzentrum Schwarzes Moor Umweltzentrum Rotes Moor



Fig. 5.3: Some Flowers of the Rhön, Lilium martagon, orchids

5.3 The Rhön Biosphere Reserve

As part of the German mountain range, the Rhön Biosphere Reserve encompasses uplands ranging from 250m up to 950m above sea level. High ground, often unforested and used as grassland, is a key characteristic of the Rhön, which is often referred to as the “Land der offenen Fernen” (land of endless horizons). The Biosphere Reserve has 26 different habitat types listed in the European Habitats Directive (FFH, European Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora). Of the 26 habitat types within the Reserve 9 habitats have a priority rating. These are all listed on Germany’s Red List of Threatened Habitat Types. (Jedicke, 2013, p.2.)

Since 2012 the Rhön has been ranked amongst the top 30 biodiverse regions in Germany (acknowledged by the German Federal Agency for Nature Conservation (BfN)). Of the total area of the Rhön Reserve, 46% is regarded as a priority for nature and many protected species within a dense network of 2000 Natura areas such as natural reserves, landscape protected areas, and core zones. Some of the most important species are e.g. the wild cat, the black stork, the black grouse, the beaver, the eagle owl, the red kite, more than 40 types of orchids, 16 types of bat, the biggest existing area of Borstengras outside the Alps as well as the biggest connected area of barren lime soil in Germany. In terms of mountain grassland the Rhön is of major importance in Germany because of its biotopes of Borstengrasrasen and the Goldhafer meadows. The Hessian part of the Rhön has the biggest troll flower site. According to the latest publication of the German Federal Agency for Nature Conservation (BfN), the most important site for the pasque flower (pulsatilla) is to be found in the Rhön. On this site alone it is estimated to have 20,000 plants.

In the course of becoming a dark sky park, the responsible authorities have realized that the protection of these habitats, animals and plants is of prime importance within the Rhön. This has also become apparent to those organisations responsible for the conservation of the Rhön Biosphere Reserve. As a consequence, the protection of the natural nightscape and the ambition of improving lighting will be manifested as a leading project in the new regional development concept (Regionales Entwicklungskonzept REK) (see also letter of support of the Verein Natur- und Lebensraum Rhön). This concept, which is currently being updated, is a very important guideline in the course of future development of the Biosphere Reserve. This means, that the ambition for the Rhön to improve the quality of the night will be central to the program period 2014 – 2020. It is planned to introduce a number of individual projects such as upgrading public and private luminaries, training courses for astronomical guides, image campaigns, species protection projects etc.

Especially the Thuringian part of the Biosphere Rhön stands out for its unfragmented landscapes. About 80 % of its landscape is not fragmented, that means these areas are not divided by larger settlements or traffic routes and therefore help to offer dark skies as there are no important sources of artificial light. In the Hessian part there are about 26 % and in the Bavarian part about 55 % of intact landscapes, which is in each case significantly more than average compared to the rest of Germany. This emphasizes the importance of nature conservation of the Rhön.



Fig.5.4: Management documents: integrated environmental report, regional development concept and the “Report for the Periodic Review of Rhön UNESCO Biosphere Reserve 2013”

Population is generally decreasing in the Biosphere Reserve (2001-2011: -6.6 %), especially in the rural areas of the Thuringian, Bavarian and the eastern parts of the Hessian shares of the Reserve. One aim of the Biosphere Reserve is to stop this decrease of population.

An important management document is the first integrated environmental report (2008) which collects environmental data of the Rhön. The “Report for the Periodic Review of Rhön UNESCO Biosphere Reserve 2013”, where the star park is mentioned as an example of the tourism sector, which combines reducing energy waste and protecting the nocturnal environment, is another relevant management document.

Another interesting point is, that after World War II the Rhön was divided into a Western (Bavaria and Hesse) and Eastern part (Fig. 5.5). Not only has this fact had an influence on population changes but also on the habits of public lighting. Whereas in the Eastern part public lighting was renovated to a large extent after the reunification (mainly in the 1990ies), the Western municipalities have still low lighting levels and now a high necessity for renovation (Hänel 2013).

In terms of tourism, the Rhön is famous for having almost no limits when it comes to hiking. There are about 5.000 km of hiking trails, which offer long-distance hikes or circular hikes with different lengths and levels of difficulty. In 2006, a new premium hiking trail, the so-called “Hochrhöner” was introduced to the public, giving the entire Rhön region a whole new quality. The “Hochrhöner” is certified with the German Hiking Seal of Approval.

Another important reason for the popularity of hiking in the Rhön is the so called Green Belt Europe, which runs from Scandinavia to the Balkans and right through the Rhön along the former border between East and West Germany and is (still) Europe's longest biotope corridor. Especially along the Eastern part of the border in Thuringia, valuable natural sources could survive in the prohibited area.

The highest mountain Wasserkuppe (950 m high) is known as the cradle of German aviation and is a top destination for gliding, paragliding and hang-gliiding, due to its good topographic and thermal conditions. (Fig. 5.6) In 1970, *Neil Armstrong* visited the Wasserkuppe and spent a night in the famous hotel Peterchens Mondfahrt (Peter and Anneli’s Journey to the Moon – a famous German-language fairy tale).



Fig. 5.5: Remaining part of the security installations at border between East and West Germany near Bix



Fig.5.6: Gliders on the Wasserkuppe

In winter sledging and skiing is another reason for people coming up to the Wasserkuppe. However, the last years showed a definite decrease in snow (in the season 2013/2014 there was hardly any snow).



The project “star park” was initiated in 2010 by a student’s group from the University of Applied Sciences Fulda at the department of social and cultural sciences. Within this project it was recognized that the aims of a star park or starlight reserve coincide very well with the aims of the Biosphere Reserve.

Fig. 5.7: Title page of the project report on the “star park Rhön”

5.4 Map of the Rhön

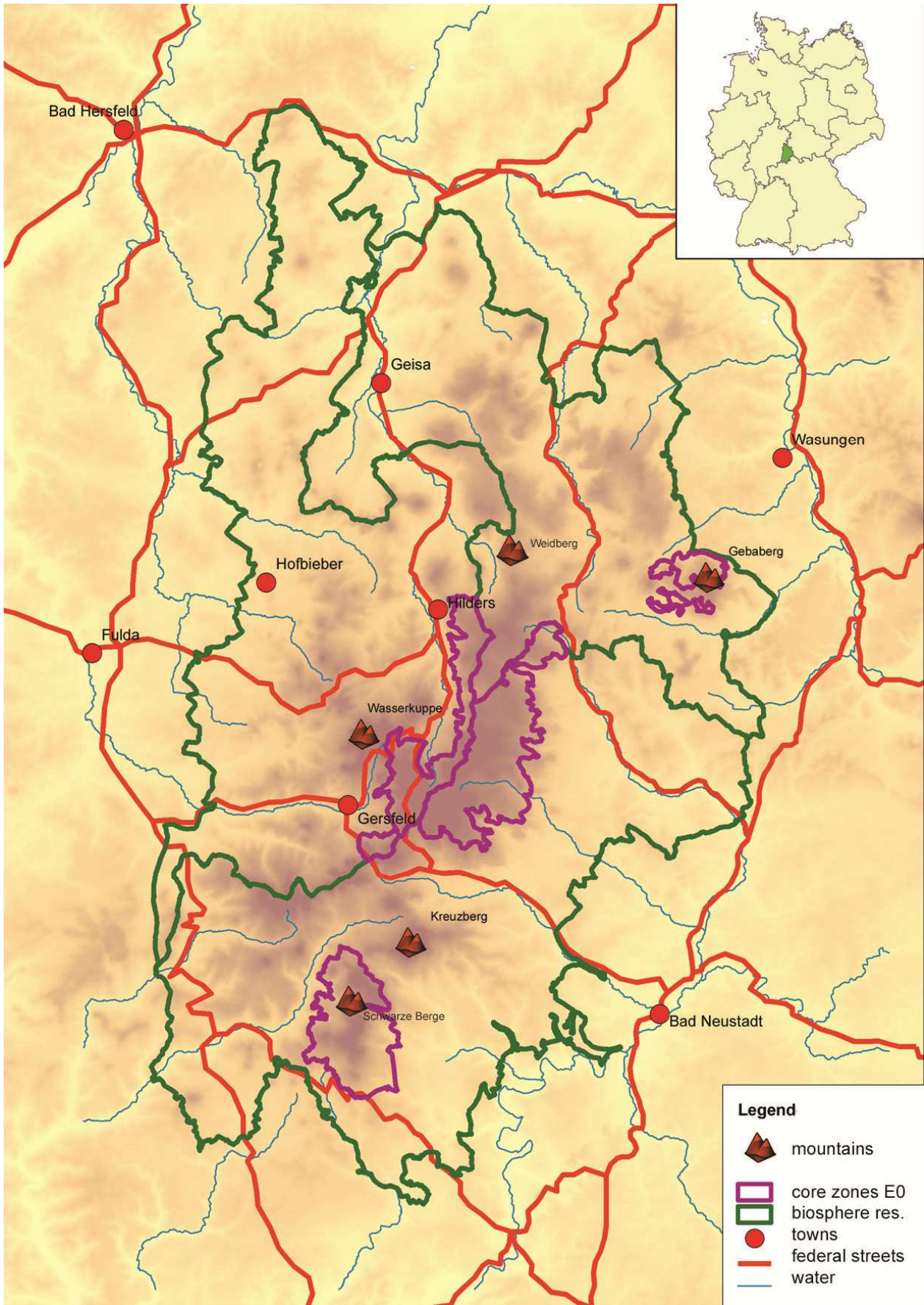


Fig. 5.8.: Map of the Rhön Biosphere Reserve: green: boundary of the Biosphere Reserve, purple: proposed star park core zones E0, red: principal roads (map: M. Müller, Biosphere Reserve Hessen)

5.5 Administrative organisation

Politically and structurally the Rhön Biosphere Reserve is part of five counties (Landkreise) with their individual towns and municipalities distributed among the three federal states of Bavaria, Hesse and Thuringia. Before the reunification of West and East Germany in the year 1990 the Thuringia part of the Rhön belonged to the former German Democratic Republic (GDR). Before reunification of West and East Germany in 1990 the Thuringia part of the Rhön belonged to the former German Democratic Republic (GDR). Bearing this dramatic fact in mind, it was a great achievement to get designated as soon as in 1991 as an UNESCO Biosphere Reserve. This shows the strong commitment of all involved institutions and political and private partners who exempted the Rhön from its reputation as one of the poorhouses of Germany by trying to develop the region towards a region where people and nature live along together in a sustainable way – just in the sense of the UNESCO program “Men and Biosphere”.

There are three administrative agencies of the Biosphere Rhön – one in each of the federal states. Each administrative agency of the Biosphere Rhön is being supported by a sub-board of trustees (the Förderverein).

The year 2000 marks the beginning of another important cross-border cooperation between these five counties by forming a close collaboration between the political heads of the five counties and the three sub-boards of trustees of the Biosphere Rhön, the so called regional working group Rhön, ARGE Rhön (Arbeitsgemeinschaft Rhön). Aim is a sustainable development and configuration of the structure of the Rhön as a common economic, cultural and natural area. In doing so the ARGE Rhön seeks to achieve the preservation of nature and landscapes as well as maintaining a robust modern agriculture and forestry and also to improve the cooperation between the partners in cultural affairs. The touristic development of the Rhön is seen as a base for preserving and creating jobs to halt the decrease of population.

The geographic scope of the ARGE encompasses mainly the eligible area of the Biosphere Rhön and the communities/municipalities within it.

The members of the executive boards are:

- the county of Rhön-Grabfeld, Federal State of Bavaria (South-Eastern part)
 - the county of Bad Kissingen, Federal State of Bavaria (South-Western part)
 - the county of Fulda, Federal State of Hesse (Western part of the BR Rhön)
 - the county Schmalkalden-Meiningen, Federal State of Thuringia (Eastern part)
 - the county Wartburgkreis, Federal State of Thuringia (Northern part)
- each represented by the elected head of the counties

registered associations:

- Verein Naturpark und Biosphärenreservat Bayerische Rhön e.V. (sub-board of trustees of the Bavarian part of the Biosphere Reserve)
 - Verein Natur und Lebensraum Rhön e.V. (sub-board of trustees of the Hessian part of the Biosphere Reserve)
 - Verein Rhönforum e.V. (sub-board of trustees of the Thuringia part of the Biosphere Reserve)
- each represented by their chairperson.

The chairman of the ARGE is one of the heads of the involved counties – following a defined interval period of two years. At the time of preparing this application, the head of the county of Schmalkalden-Meiningen, Mr Peter Heimrich, was chairman of the ARGE.

The so-called coordination committee mediates between the interests of the ARGE Rhön, the Biosphere administration offices and their sub-boards of trustees and the nature park administrations.



Fig. 5.9: The three Biosphere Reserve administrations in Zella (Thüringen), Oberelsbach (Bayern) and the Wasserkuppe (Hessen)



Fig. 5.10: The coordinating structure of state and non-state agencies in the Rhön Biosphere Reserve (Jedicke, 2013)

5.7 Climate in the Rhön

The Biosphere Reserve has a subatlantic climate with (sub-)continental influences. The weather in the Rhön is mainly influenced by different elevations and the preferential direction of the wind. On the highest mountain, the Wasserkuppe, is installed an official weather station (921m) with continuous measurements over many years. Annual rainfall varies between 500 mm on the lee sides and 1080 mm on the Wasserkuppe. The mean annual sunshine is about 1550 hours/year and is a bit less in the surrounding regions. These data could be an indicator for the chance of clear nights. In winter the mountains may lie above the fog in the valleys, but snow could hamper nightly observations.

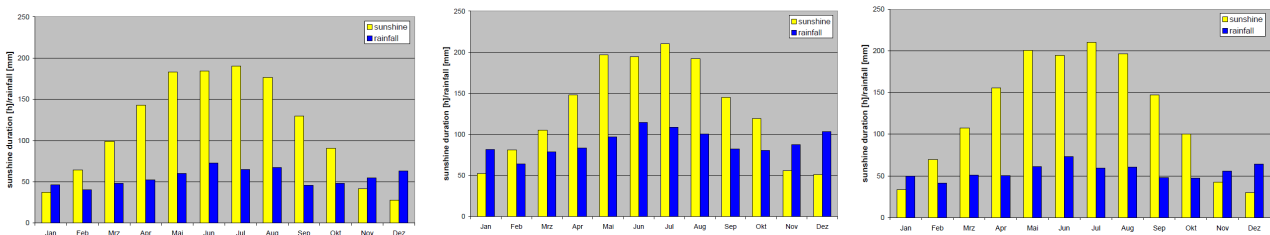


Fig. 5.11: Monthly sunshine duration (yellow) and rainfall (blue) in Fulda, Wasserkuppe and Meiningen (based on data from 1961-1990)

5.8 Species conservation projects (examples)

Among the different species, which are protected and safeguarded by the Biosphere Rhön, there are many nocturnal animals, which benefit from all measures to keep and protect the night sky and its natural nightscapes. These are for example the black grouse (Birkhuhn), the beaver, eagle owl, wildcat and the noble crayfish and plants like orchids and elderberry.

- **Bats:** In the mountain landscape of the Rhön, a total of 17 bat species are found. They live here either around the year, or are spending just the summer or the winter here. The Biosphere Reservation Rhön has set itself the task to protect the bat population. In cooperation with the working group for the protection of bats (Arbeitsgemeinschaft für Fledermausschutz) Fulda, a multitude of measurements for the protection of bats are put into practice. The Forestry Office of Hofbieber has even taken over the sponsorship for the rare Western Barbastelle. From the perspective of the voluntary bat protection, it is very important to initiate

measurements which are going beyond the usual programs. An initiative in that direction, which is decidedly supported by the bat protection community, is the project "Sternenpark Rhön". Being nocturnal animals, bats are very sensitive to light and are in need of dark hunting grounds and dark areas for retreat. Only a small number of species benefits for example from street lights, which are attracting the insects, which these bats are hunting. Given these facts, all measurements aimed at the protection of the night have to be welcomed. The project "Sternenpark Rhön" is playing here an important role. An effective protection of the night and thus of the habitats of the bats, will only be successful, if in the future illumination is set up in a more contained and intelligent way. The directive for environmental friendly illumination is an important tool for this. It is to be hoped that many communities within the Rhön will adopt this directive and put it into practical use (text *St. Zänker*).



Fig. 5.12: Information leaflet on bats from the Biosphere Reserve

- **Wildcat** (*Felis silvestris*): In 2007, a project by the Rhön nature conservation association RhönNatur e.V. provided firm genetic evidence of the presence of the Wildcat, which until then had been overlooked or was thought to have died out in the area. Together with the Allianz Umweltstiftung – Allianz Foundation for Sustainability, Frankfurt Zoological Society, the Biosphere Reserve's administration units, forestry offices, BUND/Friends of the Earth Germany and other stakeholders, the intensive use of lure sticks resulted in the identification of a total of 26 individuals in the Biosphere Reserve by November 2012. They were found to be genetically distinct from the Wildcat populations in adjacent areas. Obstacles to proliferation were identified and countermeasures taken, including the construction of three "green bridges" (wildlife crossings) and habitat enhancement measures. (*Jedicke, 2013*)

- **Noble Crayfish** (*Astacus astacus*): The German Noble Crayfish project started in 2000. After mapping the occurrence of competing species of aquarium crayfish of American origin and assessing the water bodies' suitability in terms of water quality and structure, the project carried out stocking measures annually along 14 sections of 10 streams from 2004 to 2010. The presence of offspring was first confirmed in 2008. In Thuringia, stocking first took place in 2010 and will continue until 2014. The administration units and crayfish conservation volunteers from local angling clubs are involved in crayfish monitoring within the framework of the Rhön Watercourses Working Group (AK Rhöner Fließgewässer), a voluntary initiative. (*Jedicke, 2013*)

The "Report for the Periodic Review of Rhön UNESCO Biosphere Reserve" (*Jedicke, 2013*) gives a wealth of information on the protected flora and fauna in the Rhön. This material could be an important source for future studies of the potential influence of artificial light at night on these beings.



Fig. 5.13: This picture was taken in November 2013 in Fulda and shows the influence of artificial lighting on the leaves of *Aesculus*: around the luminaires are still leaves while the rest of the trees are empty. (Foto: *Frank*)

5.9 Astronomical Tradition

In and around the Rhön there are some signs of early astronomical activities.

Near the cathedral of Fulda on the Michaelis church is a simple sundial that might be one of the oldest in Germany, dating from 800 AD. Another, more modern one, is on the baroque church of Bischofsheim.



Fig. 5.14: Ancient sundials in Fulda (left) and one baroque in Bischofsheim

In modern times public observatories of the Rhön region are installed in Bad Salzschlirf, Fulda and Meiningen. The natural science museum in Fulda has also a very active planetarium with a 6 m dome with 35 seats, modern digital projection technology and about 15.000 visitors annually.

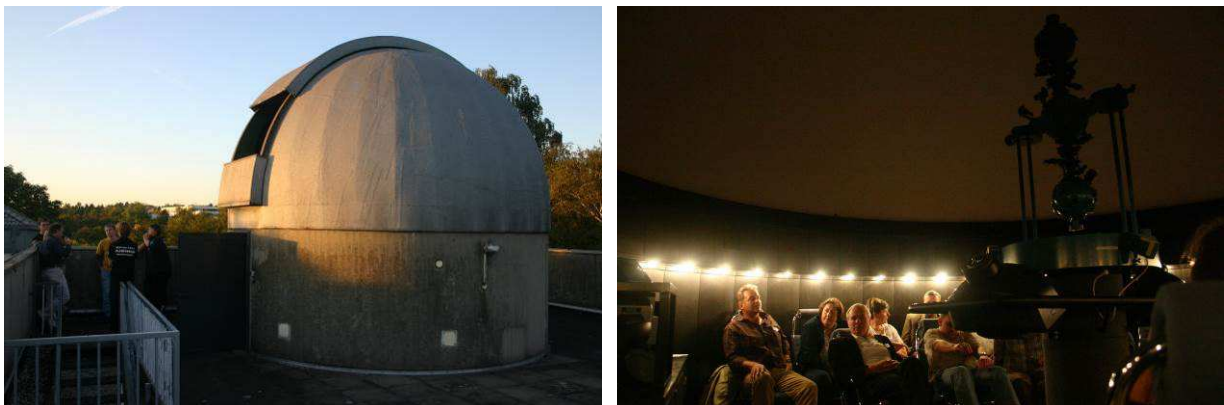


Fig. 5.15: Hans-Nüchter observatory in Fulda and Planetarium Vonderau-Museum Fulda



Fig. 5.16.: Observatory in Salzschlirf (accessible for the disabled, foto: *Passarge*)

Fig. 5.17: Observatory Meiningen (foto: *Fiedler*)

6 Night sky quality in the Rhön

From the light pollution atlas of *Cinzano et al.* (2000) one might expect only mediocre sky quality of 21.0-21.5 mag/arcsec² in the UNESCO Biosphere Reserve that is situated in the center of Germany.

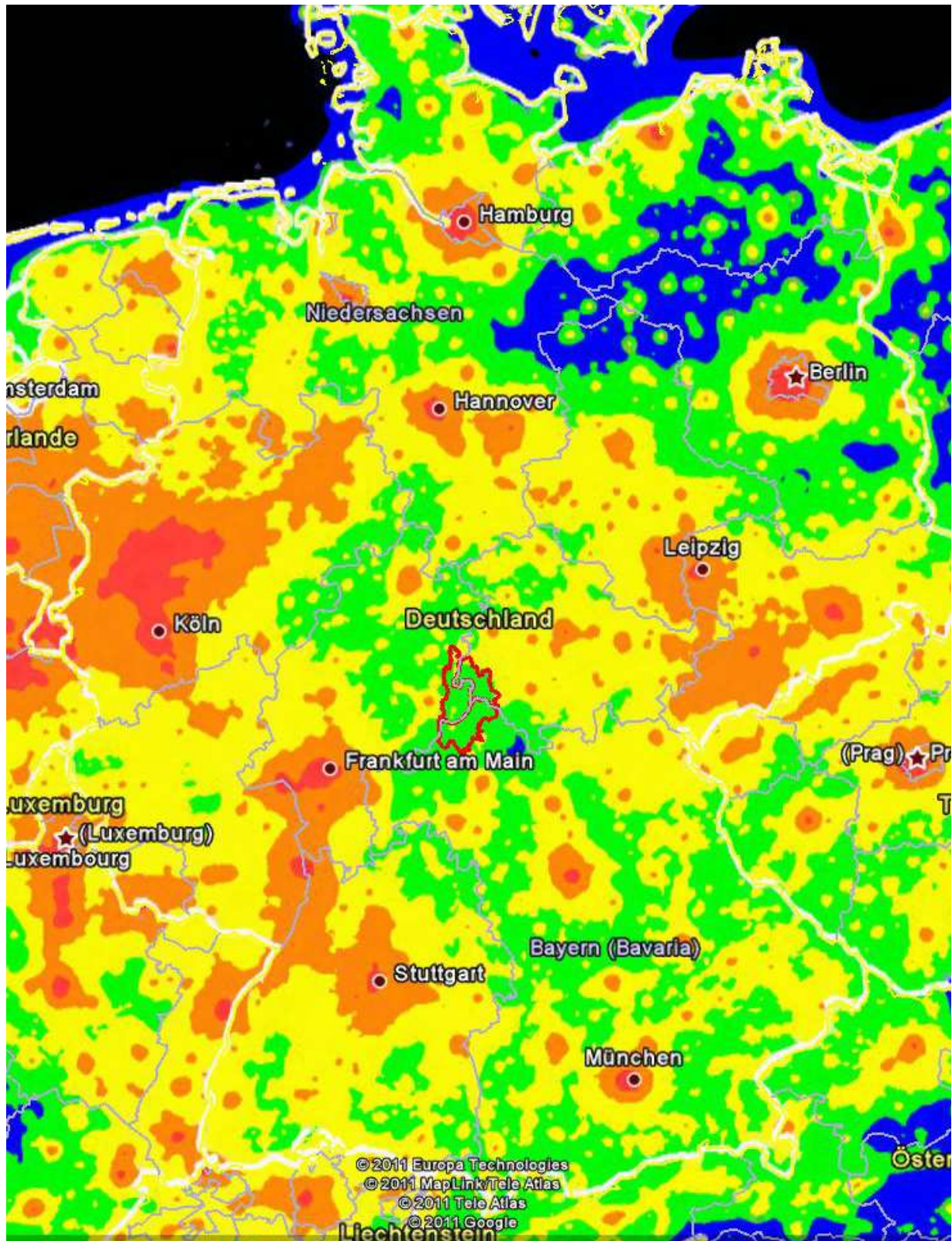


Fig. 6.1: The boundary (red) of the Rhön Biosphere Reserve has been overlaid onto a map of the artificial sky brightness from *Cinzano et al.* (2000).

Dark regions have been identified using the Defense Meteorological Satellite Program data of upward light for 2009. Some of these dark places are forests, where measurements were not possible as they were not accessible or as it was difficult to find places there with unobstructed views towards the sky. More than 130 measurements of the sky brightness have been taken with handheld Unihedron SQM-Ls between 2011 and

2014 by *Sabine Frank* (#2495) and *Andreas Hänel* (#2536). The SQM #2495 measures about 0.07 mag/arcsec² darker than the SQM #2536, which is used as the reference instrument by the German dark sky group. The individual values are listed in the appendix A1.

The measurements are influenced by different factors:

- The Milky Way increases the sky brightness by about 0.3-0.4 mag/arcsec² for the summer and 0.2 mag/arcsec² for the winter Milky Way.
- The sky background decreases during the evening hours as artificial lights are switched off. This effect is smaller in dark places than close to cities, but can amount up to 0.4 mag/arcsec² from the end of astronomical twilight until midnight.
- Some thin clouds influence the background brightness, this may have an effect of up to 0.2 mag/arcsec². This is confirmed by the measurements by *Kyba et al. (2011)*, who found an increase of sky brightness by 0.2 mag/arcsec² in a rural place with a cloud cover of 1 Okta.

At some places measurements were taken at different times for reference reasons and we tried to correct the data for the various influences during different nights. Therefore we created a map with the direct uncorrected measurements, where only the small instrumental differences have been corrected (fig. 6.3), and another with the values, which have been corrected for the influence of the Milky Way (fig. 6.4). DMSP data for 2010 have been color coded and used as a background map, the method for generating these maps has been described by *Hänel (2006)*. Further on, the 2012 VIIRS data have also been used as background.

In addition all-sky DSLR photos with identical exposure data were taken (Canon 1000D, 800 ASA, RAW data, 3 minutes exposure time, Sigma 4.5 mm f/2.8 fisheye) on different nights and at different locations. These photos show the variations due to the influence of the Milky Way or different atmospheric transmissions. But they confirm that the sky is homogeneously dark over the core zones (fig. 6.5). As simultaneously SQM-L measurements have been taken, the pictures are calibrated and intensity values from the camera can be transformed to brightness values. This has also been done for some photos by *Zoltan Kollath* with the method he developed (fig. 6.2).

Since July 2011 we have also taken sky brightness measurements with the Roadrunner system. A SQM-LU and a GPS receiver are mounted on the roof of a car and software developed by *Daniel Rosa Infantes* stores positions and sky brightness values at fixed time intervals. This is a very effective method to collect many measurements in regions where there are not many obstacles like trees, buildings or street lamps along the route. Trees that are illuminated by the headlights of the car disturb the measurements as they increase the brightness. Therefore only the baseline can be used as a characteristic value (fig. A3). Some routes have been followed in the Lange Rhön, where few trees influence the measurements. They confirm that the region really has dark skies (fig. 6.6).

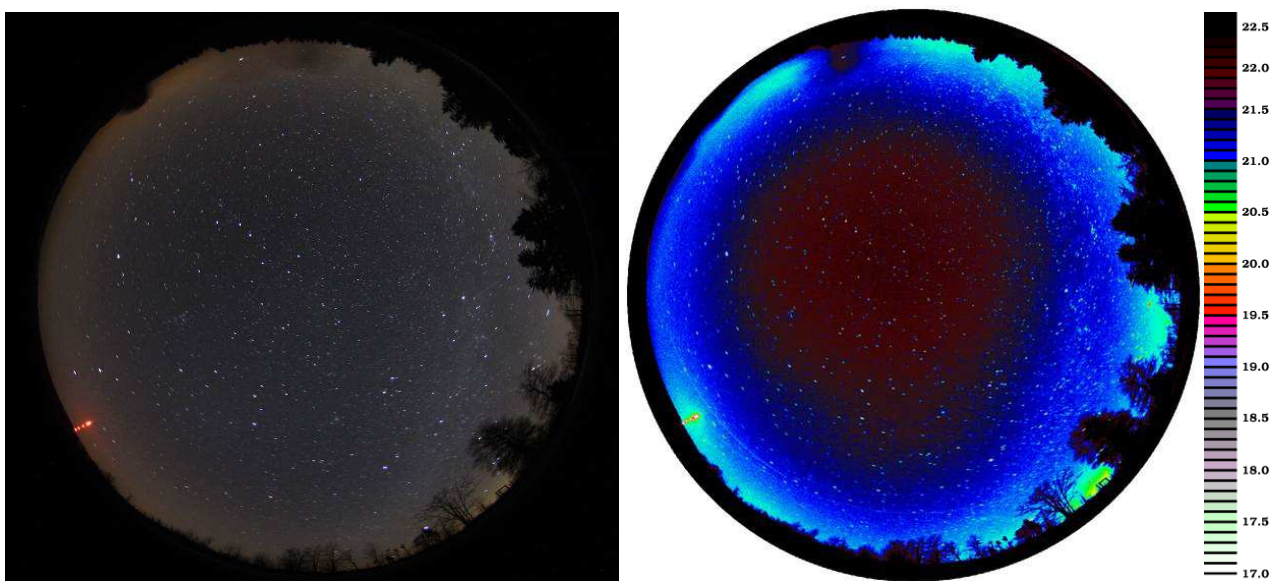


Fig. 6.2: All-Sky pictures taken at the Moorwiese in the Rhön. The calibration to skybrightness values was done by *Z. Kollath*.

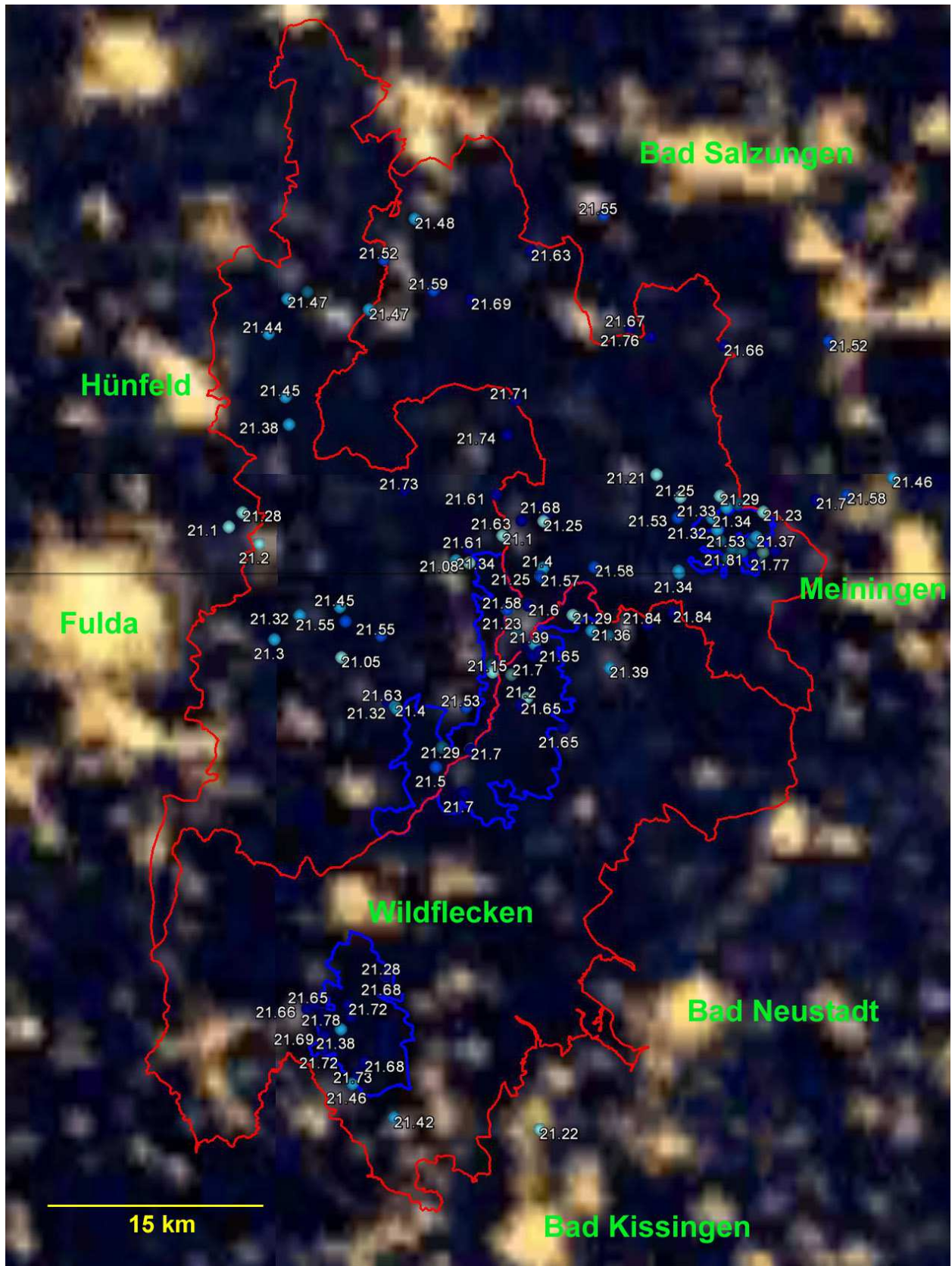


Fig. 6.3: Sky brightness measurements with instrumental differences corrected in the Rhön Biosphere Reserve, overlaid on VIIRS data from 2012. The reserve boundary is outlined in red, the proposed core zones blue, the measurements are color coded with dark blue being darkest and bright blue to yellow being brighter skies.

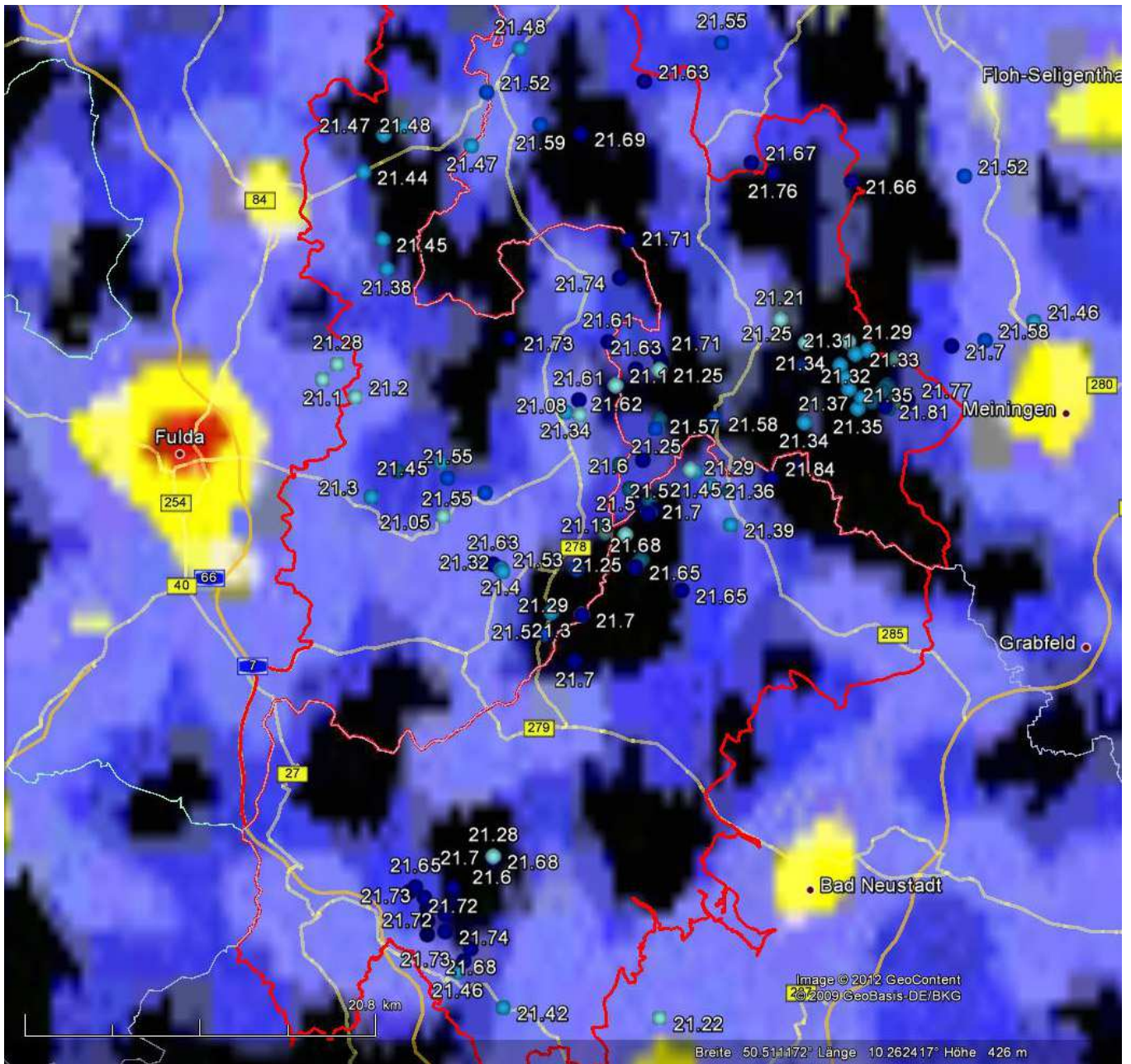


Fig. 6.4: Reduced sky brightness in the Rhön Biosphere Reserve, overlaid on a DMSP map from 2010. The measured brightness values have been corrected for the influence of the Milky Way. The reserve boundary is outlined in red, the measurements are color coded, with dark blue being darkest and bright blue to yellow being brighter skies.

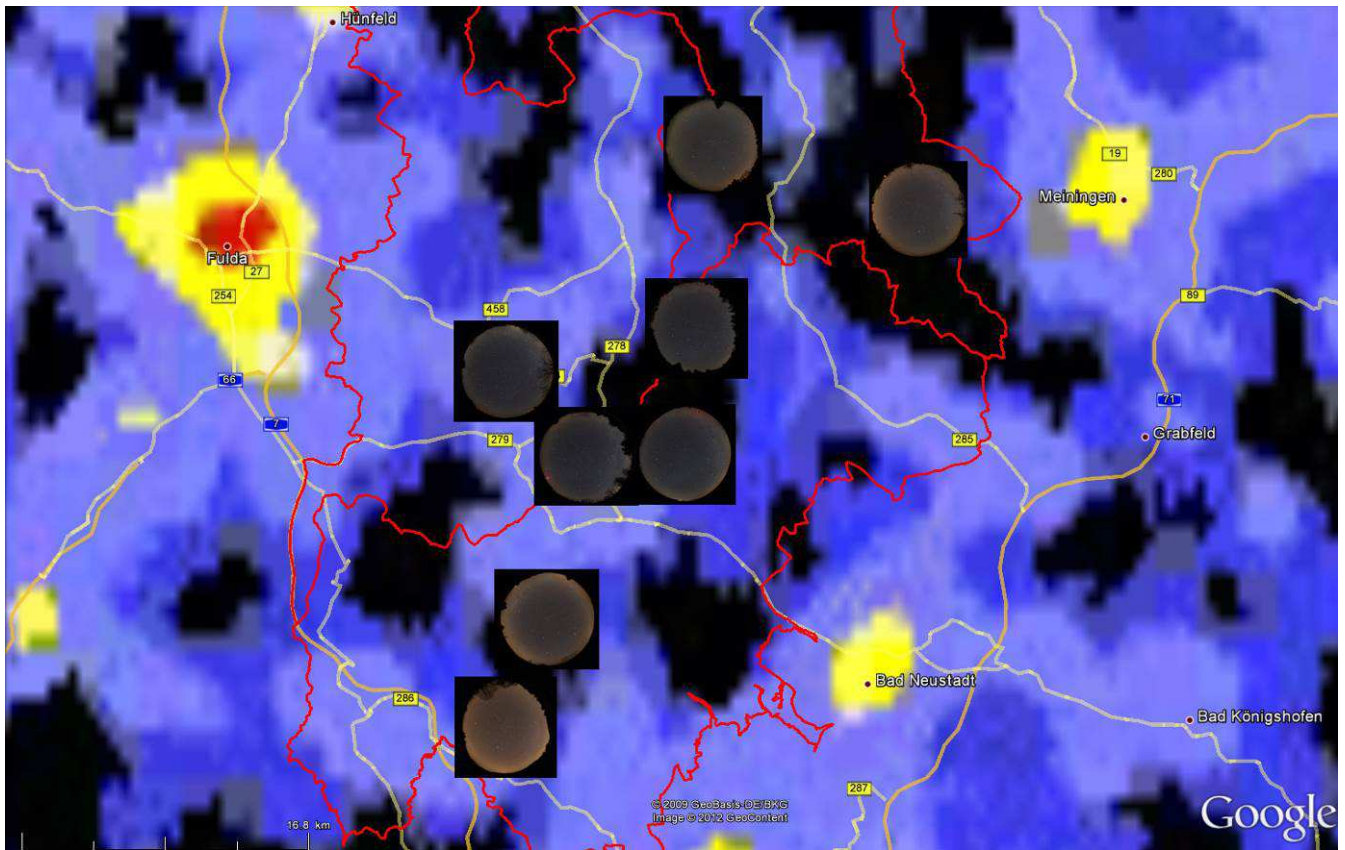


Fig. 6.5: All-sky pictures taken in the Rhön overlaid on the DMSP 2010 map.

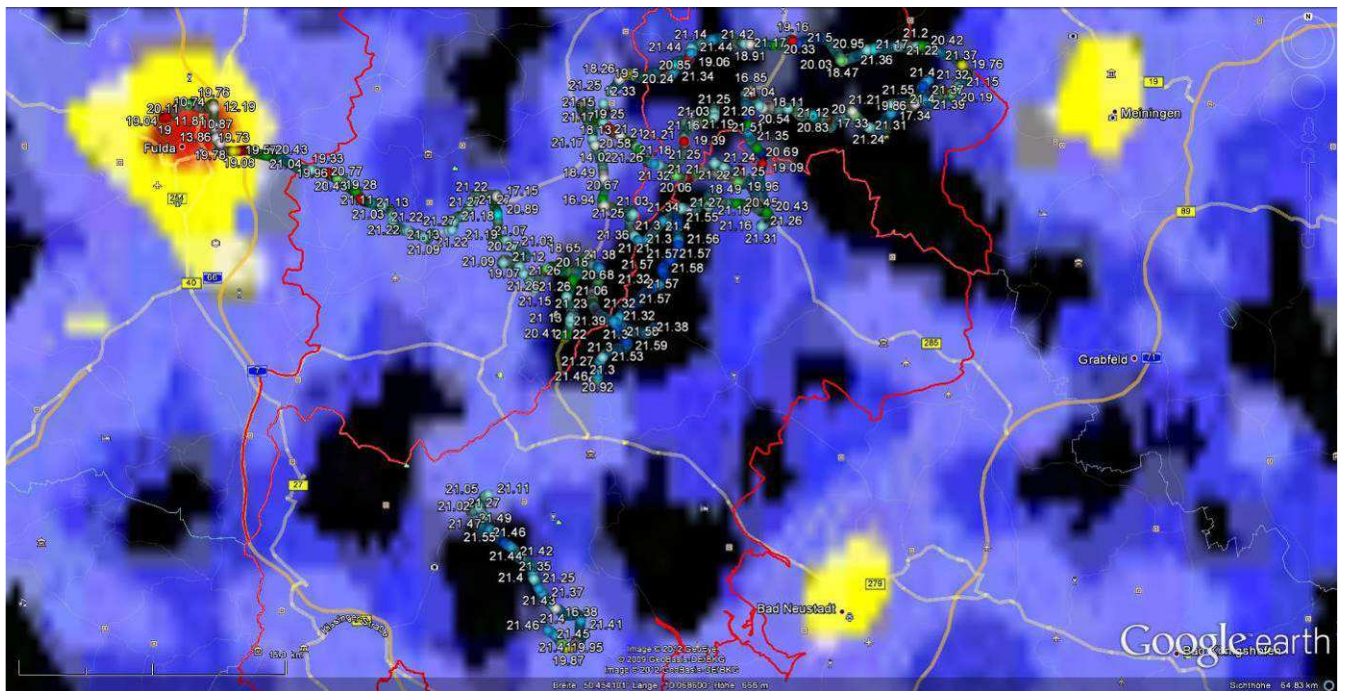


Fig. 6.6.: Roadrunner measurements taken with a SQM-LU and a GPS receiver overlaid on the DMSP2010 map.

Airglow 2012

In the night 2012 July 22/23 faint colorless clouds could be observed first at the Weidberg and later at Hohe Geba. The all-sky pictures showed the green color of these clouds, which are typical airglow clouds and only visible under dark skies.



Fig. 6.7: Green airglow as observed from Hohe Geba on July 22/23, 2012, exposure time 3 min, 1:2,8, f=4.5 mm, ISO 800, Canon 1000D.

General conclusions

As can be seen from these data, the DMSP and the VIIRS maps represent the sky brightness on a small-scale structure much better than the sky brightness map by Cinzano et al. (2000), proving their usefulness for identifying areas with natural darkness.

Several main dark areas can be identified on the maps and from the measurements. They mainly coincide with the core zones and the buffer zones of the Biosphere Reserve (fig. 6.9):

- Geisaer Wald in the North (Thüringen), a remote area that is not very accessible and does offer few unobstructed views of the sky.
- Hohe Geba mountain in the east (Thüringen): the sky is very dark but the eastern horizon is influenced by the light dome of the city Meiningen (21.000 inhabitants).
- Lange Rhön (all federal states) is the central area which is most nature protected. As it is furthest away from larger settlements it is also the darkest area.
- The military terrain Wildflecken in the Southwest (Hessen and Bayern), which normally is not accessible.
- The Schwarze Berge (black mountains) in the South (Bayern).
- Burgwallbacher forest and others in the Southeast (Bayern) which are hardly accessible and do not offer unobstructed views of the sky.

Sky brightness increases by about 0.2 - 0.3 mag/arcsec² towards the borders of the small villages.

The variation of the sky brightness over these dark areas of the Rhön Biosphere Reserve is small. Outside the villages, the zenithal sky background is 21.5 - 21.7 mag/arcsec² in dark clear nights without the Milky Way. This is close to the natural dark sky brightness of about 21.8 mag/arcsec². This is confirmed by the observation of the zodiacal light in spring (especially February) and even the much fainter Gegenschein (fig. 6.8). The globular cluster M15 and the galaxy M33 were visible

and the limiting magnitude was observed to be 6.7 mag, indicating at least Class 3 of the Bortle scale. In July 2012 even the faint airglow was visible from the Rhön (fig. 6.7). In dry weather in some parts of the Lange Rhön even no light domes of surrounding villages are visible, which emphasizes the quality of the nocturnal environment.



Fig. 6.8: All-sky picture taken at the parking lot Rotes Moor, same exposure data as in fig. 6.7. In this contrast enhanced picture the zodiacal band can be followed over the Milky Way, the Gegenschein is visible under the Lion (date 4th March 2011). The light dome at lower right is from the city of Gersfeld in the Southwest.

This could be compared to observations at other dark places with the same SQM-L, so instrumental changes should be negligible. If available, measurements for spring (without) and autumn (with Milky Way) are given. Though the measurements were taken in clear moonless nights, meteorological influences make it difficult to define a characteristic value for one place.

Country	Place	Longitude	Latitude	Altitude	SB spring	SB autumn	SB best
Germany	Westhavelland	12.477	52.712	30	21.78	21.45	21.78
	Rhön	9.985	50.460	840	21.78	21.30	21.78
	Harz	10.677	51.738	540	21.73	21.20	21.73
	Herzberg	13.272	51.708	85		21.35	21.78
	Altmark	11.459	52.896	20		21.30	
	Eifel	6.358	50.505	680		21.05	21.60
	Swabian Alb	9.334	48.222	800	21.75	21.17	21.75
UK	Exmoor*	-3.256	51.078	200		21.00	21.80
France	Quercy	1.685	44.708	380		21.65	
CZ/PL	Jizera	15.340	50.824	900		21.20	21.65
Spain	Montsec	0.743	42.048	1500		21.65	22.10
	Tenerife	-16.611	28.258	2300	21.45		21.40
	La Palma	-17.867	28.761	2250		21.60	21.90
Hungary	Zselic	17.686	46.255	170		21.40	21.60
Croatia	Lastovo	16.856	42.743	350		21.60	22.00
USA	Great Sand Dunes	-105.517	37.738	2455	21.80		
	Natural Bridges	-109.354	37.462	1980	21.68		21.95
	Death Valley	-116.977	36.724	700	21.72		21.88

Tab. 6.1: Sky brightness measured with the same SQM-L at different dark places in Europe (* east of the park) and North America. Besides the coordinates of the observing places, the altitude (in m) and the measured sky brightness (mag/arcsec²) in spring (SB spring) and in summer/autumn/winter (SB autumn) are given. The darkest measured sky brightness (SB best) was taken from different publications.

Proposed International Dark Sky Reserve Rhön

Respecting the accessibility, the darkness of the sky and an adequate distribution in the different federal states, three core zones are finally proposed. Their limits correspond mainly to the nature protected areas and to the buffer zone (Pflegezone A) of the Biosphere Reserve (fig. 6.9). The core zones are also Fauna Flora Habitat (FFH), special areas of conservation (SAC) (Natura 2000 European habitat protection) and special protected areas (SPA) for birds (Natura 2000 bird sanctuaries). Therefore they are highly protected under European, national and regional law, they have not yet been classified according to IUCN (International Union for the Conservation of Nature and Natural Resources) categories. The strong regulations in the Biosphere core and buffer zones apply to public and privately owned (relative fractions are not known, partly due to data protection) land, 80% of the area of the Biosphere Reserve are protected by law (landscape protection), 46% are in particular protected under national and European nature protection regulations.

But as protected areas are defined differently in the various states, the limits for the starlight core zone of Hohe Geba Mountain in Thüringen are defined by the FFH and SPA areas. This place was chosen for its exceptional sky conditions, the situation in Thüringen and the engagement of the relevant municipality Rhönblick. The small town Geba in the middle is excluded from protected areas like the settlements in the whole reserve. However it is planned that the 5 non compliant luminaires in the town will be exchanged as soon as funding is available.

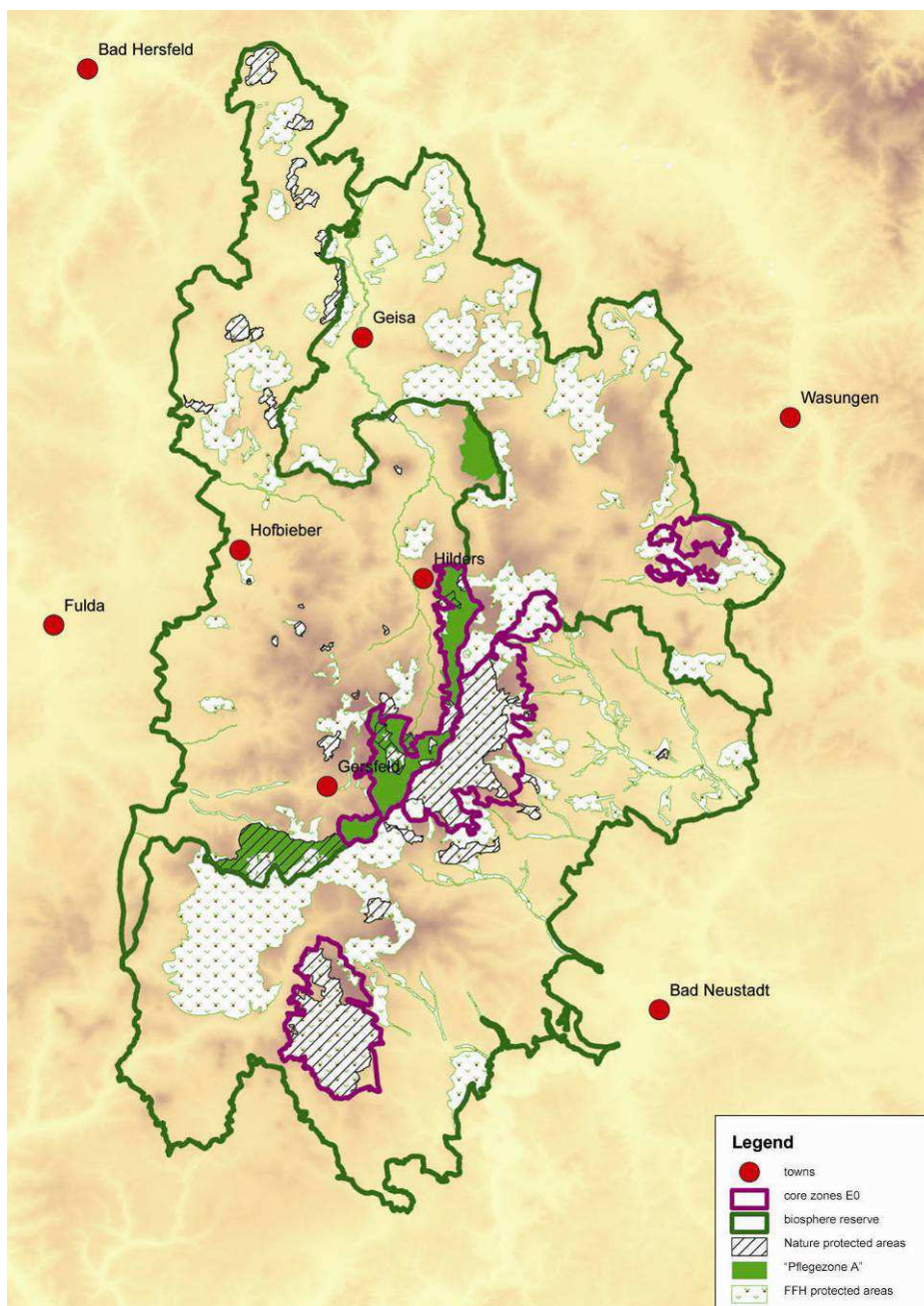


Fig. 6.9: Nature protected areas (black hashed), core zone in Hessen (Pflegezone A) (green) and FFH protected areas (dotted areas) in the Biosphere Reserve (green line), with the star light core zones E0 (purple) (map: M. Müller, Biosphere Reserve Hessen)

Proposed star light core zones (E0) (to distinguish them from Biosphere Reserve core zones) in the Rhön Biosphere Reserve:

1. Hohe Geba in the East (state of Thuringia), 9.7 km²
2. Lange Rhön in the centre (states of Hesse and Bavaria), 94.1 km²
3. Schwarze Berge (state of Bavaria) in the South, 41.2 km²

Proposed star light buffer zone (E1):

This zone is defined by the boundaries of all communities that directly border the core zones. The size of this zone is about 874 km².

Proposed outer star light buffer zone (E2):

This zone is defined by the communities outside of zone E1 but within the boundaries of the Biosphere Reserve without the communities in the far North of the Biosphere Reserve.

The core zones coincide with the most typical and protected areas of the Biosphere Reserve. The protected areas to the Southwest was excluded because it is military terrain (Wildflecken) and therefore generally not open to the public.

The aim on short-term is to protect the natural sky in the core zones by reducing the main disturbing individual artificial lights in the surrounding buffer zone E1.

On a longer term (typically 10 years) it is intended that the three core zones might merge to one larger core zone. For this reason in some larger villages (especially Fladungen and Bischofsheim) most luminaires need to be retrofitted according to the lighting master plan.

The most protected core zones of the Lange Rhön and the Schwarze Berge can be transited by car on public roads by day and night, but parking is not allowed in order to protect wildlife. Hiking or skiing (in winter) is only possible on specifically identified paths. But in the proximity of the highly protected areas there are some public parking lots where observations at night are possible. Alternatively there are other places with dark skies that can be found in the surrounding area, some are mentioned in Chapter 10.

As the correct term „Dark Sky Reserve“ is difficult to translate into German and the word “dark” would have a negative connotation, we prefer in German the term star park “Sternenpark im Biosphärenreservat Rhön”.

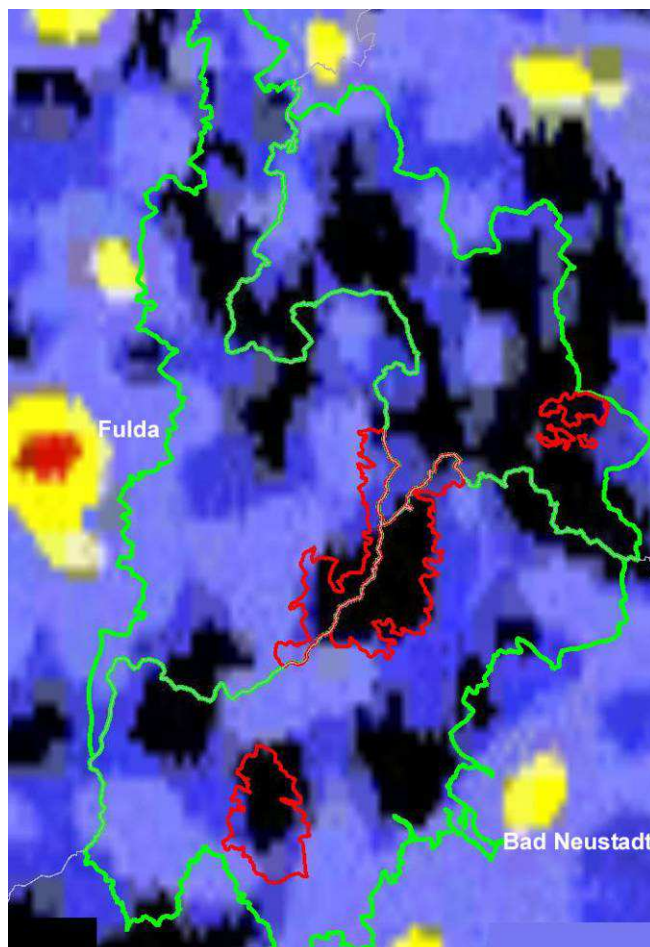


Fig. 6.10: Proposed borders of the ("starlight") core zones (red) and the whole Biosphere Reserve (green) overlaid on the DMSP 2010 map.

7 Lighting inventory

7.1 Lighting panoramas

The contributors to the artificial sky brightness can be identified from satellite imagery, especially the VIIRS data from 2012, which have been evaluated together with the sky brightness measurements in chapter 6. Another method to identify the light polluters is taking panoramic pictures of the settlements which were taken for several places as the Rhön is mountainous. The estimated upward light ratio (ULR) and the amount of upward light (in klm = kilo Lumen) were taken from the lighting inventory (appendix A 2.3), but refers only to the public lighting. Illumination (especially of churches seems to be the second contributor) or industrial/commercial are not included in these numbers.



Fig. 7.1: Katzenstein, view towards the East (Empfertshausen)



Fig. 7.2: Ellbogen view towards West: Ober-, Unterweid, Tann, Simmershausen



Fig. 7.3: Frankenheim: Industrial complex with white light to the right (ULR=10.8%, 1109 klm)



Fig. 7.4: Hohe Geba towards the West, illumination of church Brüchs (see chapter 9.7)

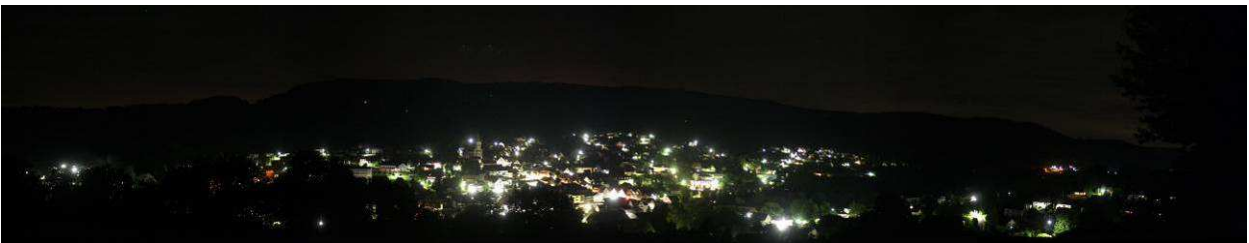


Fig. 7.5: Hilders: unshielded street light (ULR=13.5%, 1652 klm)



Fig. 7.6: Seiferts: street lights (ULR=5.1%, 437 klm) and badly illuminated church, light dome of Fulda (background)



Fig. 7.7: Wüstensachsen: street lights (ULR=4.7%, 854 klm) and badly illuminated church



Fig. 7.8: Gersfeld: Mainly badly shielded lights in the center (ULR=11.6%, 1746 klm)



Fig. 7.9: Bischofsheim from the Southwest (ULR=12.3%, 2024 klm)



Fig. 7.10: Wildflecken: left: Oberwildflecken, street lighting (ULR=5.5%, 1249 klm) and a brightly illuminated industrial complex



Fig. 7.11: Kreuzberg: view far towards the South, mainly street lighting

Most of these panoramic pictures were taken from the proposed core zones. The following main sources of artificial lighting can be identified on these panoramic pictures:

- public street lighting is the most important contributor in the villages and often not fully shielded,
- some badly oriented façade illuminations are far reaching disturbing light sources,
- some industrial or commercial complexes can also be important light sources.

7.2 Core Zones E0

Artificial lighting in the core zones is mainly private at few houses and a quarry. Most lamps have less than 1000 lumens and are only used when it is necessary (by switching on and off). They were inspected during day and especially during night several times. **Most were normally switched off during night** and switched on only when necessary, sometimes through motion detectors, most by switches.

The lighting inventory for the core zones is presented in appendix A2.1. Most luminaires fulfill the criteria for dark core zones, some can easily put into compliance. Only 8 luminaires (mainly working and security light in the quarry), which corresponds to a fraction of 7% of all luminaires in the core zones, need to be adjusted or exchanged, most are simply switched off.

Unexpectedly, disturbing light sources near some proposed observing places are indoor lights from unshielded windows, which is not theme of lighting guidelines for outdoor lighting and therefore difficult to regulate. However the inhabitants (mainly restaurants/hotels) have been contacted and some have meanwhile reduced the lights and/or shielded them (e.g. through curtains). They have already realized that astro-tourism will become a growing market segment and therefore protecting the dark around their houses will help to attract stargazers.



Fig. 7.12: Lights from windows at Hohe Geba (left) and Kissinger Hütte (right) appear so bright due to long exposure times, some are shielded now.

The lighting on the TV towers (Heidelstein and Kreuzberg) is necessary security lighting, which is regulated. Due to its red color the disturbance to night observation and night life is limited.



Fig. 7.13: TV tower Heidelstein.with security (air traffic) lighting.

7.3 Buffer Zone E1

7.3.1 Illuminations

Façade illuminations in the inner buffer zone close to the core zone are mainly church illuminations.



Fig. 7.14: Illuminated churches in Brüchs (left) and Oberelsbach



Fig. 7.15: Illuminated churches in Seiferts (left) and Wüstensachsen



Fig. 7.16: Bischofsheim, church still illuminated after midnight, Fladungen town gate

Due to the lighting guidelines for the star park, some of the churches already switch off the lighting earlier in the evenings, others will change the orientation of the lighting beam that they no longer illuminate the sky.

7.3.2 Commercial lighting

Commercial lighting is mainly due to some larger hotels and some smaller industrial complexes. Some hotels reduce their lighting during the night.



Fig. 7.17: Hausen, Rhönpark-Hotel, Rother Kuppe, street lighting and hotel



Fig. 7.18: Brewery Roth is illuminated all night, industrial district Frankenheim with illuminated aluminum facade.

Other hotels have been contacted and they will change their lighting, when they do new installations or renovations. It is helpful to demonstrate some positive examples like the following:



Fig. 7.19: Some positive examples: left: an industrial hall using only full cut-off luminaires that the view towards the stars is not disturbed too much (Frankenheim). Right: a supermarket in the foreground switches off lighting after the end of the business hours, the other one behind uses full cut-off luminaires (Hilders)

7.3.3 Skiing runs



Fig. 7.20: Illuminated skiing area on the Wasserkuppe

Due to the height several skiing runs exist in the Rhön Biosphere Reserve, but can only be used during few weeks in winter, in some winters even not at all, which might be already signs of the climate change. Most are not illuminated. The one on the Wasserkuppe is illuminated some few evenings. Beside the light reflected from the snow, the floodlights are not very well adjusted and emit much light towards the sky. Adjustment of these could reduce the amount of upward light, the light reflected from snow can only be reduced by reducing the total amount of light. Measurements however showed that the levels do not yet correspond to values proposed by the norms. The lighting certainly would disturb astronomical observations considerably in the near surroundings, however under these weather conditions observations are also very limited. The owners are willing to discuss ways of improving the lighting.

7.3.4 Public street lighting

The light domes over the villages in the buffer zone E1 are the main disturbing light sources and are originating mainly from public lighting. To estimate the amount of disturbing upward light and to identify the main disturbing sources, a lighting inventory of the buffer zone was created. It was difficult to get this information as the villages often had no inventories themselves. Some energy suppliers could provide detailed inventories, but in some villages there were even different suppliers with data of varying quality. Part of the data was collected by *Sabine Frank* and *Andreas Hänel*. Most work on the Bavarian villages was done by *Jörg Rehmann* from the Bavarian Biosphere Reserve administration. Further important data was provided by EON Bayern (Bayernwerk) and the Überlandwerk (RhönEnergie) Fulda. A total data base of about 6000 luminaires mainly of the communities in the buffer zone E1 was collected.

As far as possible the following data was gathered:

- Position of the fixture (data taken with a mobile smartphone with GIS application)
- Type of fixture
- Type of lamp and power rating (wattage)
- Times of switch-off or reduction

The type of **fixture** must be known in order to determine its upward light ratio (ULR). If the manufacturer is known, it is possible to search for the photometric data. With software like Dialux (www.dial.de) it is then possible to calculate the ULR. Sometimes this was however difficult as the manufacturer could not be identified, no photometric data existed for the model or the model was too old. Therefore we tried to derive the ULR from similar models for which photometric data was available.



Fig. 7.21: Typical luminaires in the Rhön. The fixtures in the top row and the two at the bottom left have typically ULR = 10-25 %, the others have typically ULR = 5 and 2 %.

Another problem was the identification of the **lamps**. In most villages mercury high pressure (HQL) lamps are still being used, mostly with a power rating of 80 Watt and a luminous flux of 4000 lumens. As their trade will be forbidden from the year 2015 they are often replaced with 70 Watt sodium high pressure lamps (SON) that due to higher efficiency have typically 6000 lm. The long fixtures use fluorescent tubes typically with 2 x 40 W tubes with a total of 7000 lm

Due to these uncertainties we estimate that the following numbers are accurate with an error of about 10% - 20%. The individual data is collected in data files, summary data for the villages is given in appendix A2.2.

The municipalities in the buffer zone have about 40.000 inhabitants and 6000 luminaires. They have an electrical power of 420 kW and produce 30.5 Mlm (Megalumen). Only 22 % of the fixtures are cut-off (defined as ULR <1%) at the moment. The estimated upward flux is about 2.5 Mlm, so the mean ULR is about 8%. However this is not the flux towards the sky as a certain amount is shielded by buildings and vegetation. Furthermore, many villages reduce lighting during night by partial or total switch-off, so that the amount of light is reduced during the night.

Therefore the main aim must be to reduce the upward flux by installing more cut-off fixtures in the future and reducing the amount of light during night by switching off.

But due to the bad financial situation of the municipalities, the exchange of the fixtures can only be done on a long term perspective.

From the lighting inventory some interesting characteristic values can be derived and compared:

The power rating per inhabitant is typically 10.5 Watt. With a typical illumination time of 4000 hours per year the energy consumption is 40 kWh/person, which corresponds to the average energy consumption for public lighting in Germany.

The mean luminous flux per person in the buffer zone E1 is 765 lm/inhabitant, varying between 400 ... 1400. These values correspond to values derived for Dutch villages in 1986 (Schreuder, p. 735), but is just $\frac{3}{4}$ of the often used value of 1000 lm/inhabitant and lower than values from other inventories (e.g. Luginbuhl et al., 2009).

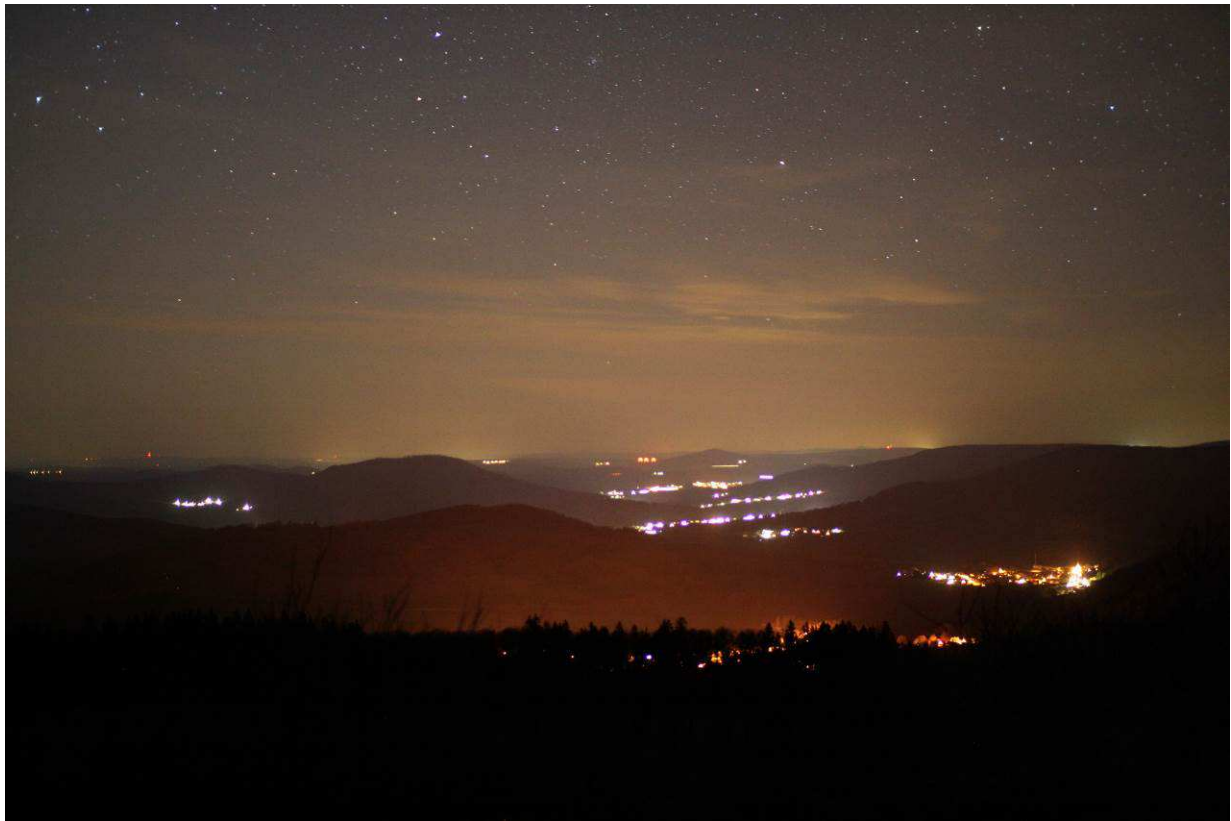


Fig. 7.22: This photo taken from the Ellbogen Mountain shows the different influences of public lighting. In the foreground a village with a high amount of ULR (15%) produces a yellow light dome clearly visible. At the right another village with a lower ULR (9%), but about 20% more light, produces a less diffuse light dome. On the horizon in the background light domes from larger villages can be seen.



Fig. 7.23: This picture from the city of Fulda (64 000 inhabitants, just outside the borders of the Biosphere Reserve) shows that houses shield the street lighting, but the facades reflect the light diffusely.

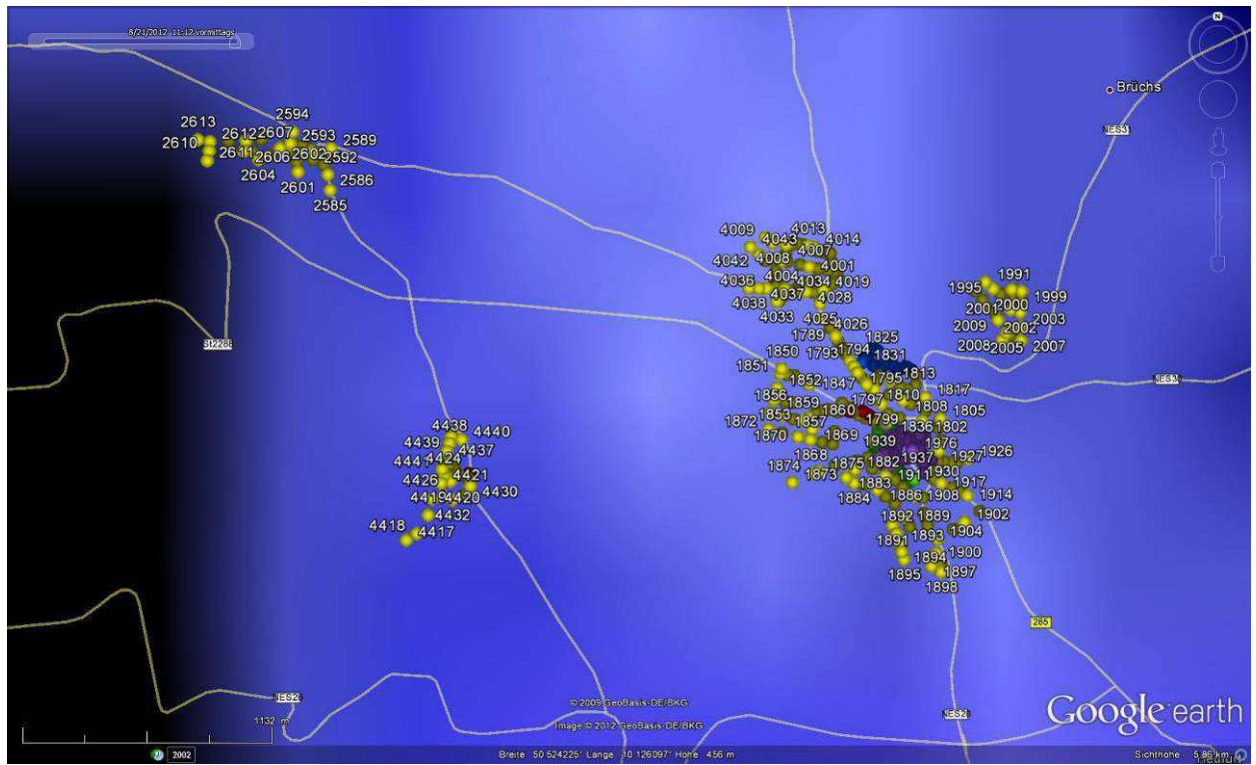


Fig. 7.24: A sample of the lighting inventory of the city of Fladungen overlaid on the DMSP 2010 map.



Fig. 7.25: The Pleiades, photo taken at the Schwarze Moor (Foto: *Werner Klug*)

8 Lighting Management Plan

Lighting guidelines have been worked out by the working group Dark Sky of the German amateur astronomers' association (Vereinigung der Sternfreunde) together with the administrations of the Nature Park Westhavelland and the Rhön Biosphere Reserve. They are based on the guidelines for International Dark Sky Reserves of the IDA (vers. 1.2, March 2008), the guidelines for Dark Sky Preserves of the RASC, the Starlight reserve recommendations and recent scientific results and publications.

A draft version has been presented to and discussed with the regional firms providing artificial lighting to the municipalities in the Rhön in June 2012. 12 people participated and discussed the draft. They were also discussed with *Rene van Ratingen*, a well-known lighting engineer working at a large lighting firm. Many discussions with people who are responsible for lighting (municipalities, energy suppliers, local electricians) showed that guidelines for lighting must be as concise as possible.

They fulfill the new IDA guidelines (vers. May 2013) concerning the blue content of lamps as they require a color temperature of 3000 K or less. They do not fulfill the 600 lm limit for unshielded light, because they had been presented to the public and printed before the release of the revised IDA guidelines. Yet this point is addressed in public hearings.

They have been approved by the Biosphere Reserve administrations in the three states Bayern, Hessen and Thüringen and were printed in early 2013.



The guidelines contain the following documents:

- Foreword by the head of the ARGE Rhön with some general information about the project,
- pre-formulated decisions for the municipal councils,
- the guidelines themselves,
- explanations accompanying these decisions on how to reduce light pollution,
- a separate list of examples of full cut-off luminaires available on the German market, which has already been updated several times according to changes in the market.

Fig. 8.1: The printed lighting guidelines

Within the Rhön Biosphere Reserve, the following lighting guidelines will be applied (details in appendix A3):

Starlight Core Zones E0

No artificial (public and private) lighting should be installed in the core of the dark sky reserve.

If artificial lighting should be necessary (e.g. for security reasons), it must:

- be explained why light is necessary,
- use full cut-off fixtures if lamps are brighter than 1000 lumens, but working towards a limit of 600 lm.,
- use preferably yellow or warm white colour (correlated colour temperature 3000 K or less),
- be switched-on only when necessary.

Starlight Buffer Zone E1

The darkness in the core zone will be protected through buffer zone E1 surrounding the cores with a total area of 873 km². This zone is defined by the communities that are part of the core zones E0 or that directly border the core zones. Some of these however do not belong to the Biosphere Reserve, especially in the Northeast and in the South. In Bavaria some areas are state forests where by law construction and therefore also lighting installations are prohibited. Generally the area outside of the settlements is controlled by regional, national and/or European nature protection laws, any changes or installations are strongly regulated. Within the settlements the councils of the municipalities are responsible for the **public lighting**. In the villages of the buffer zone luminaires must be installed according to the lighting guidelines, when new luminaires are installed or old fixtures need to be replaced. The local governing bodies of the municipalities of zone E1, which have to take formal decisions to support the star park and to follow the lighting guidelines, are listed in table 8.1.

	Area [km ²]	Inhab.
Biosphere Reserve	1865	
Communities in Buffer Zone E1		
Thüringen		
Rhönblick	76.16	2806
Stepfershausen	15.76	641
Oberkatz	9.12	277
Unterkatz	9.83	388
Aschenhausen	3.61	178
Kaltensundheim	11.78	785
Erbenhausen	20.68	556
Kaltenwestheim	19.36	953
Melpers	2.85	91
Unterweid	7.13	459
Oberweid	10.19	529
Frankenheim	9.11	1126
Birx	2.79	181
Bayern		
Bischofsheim	67.72	4794
Oberelsbach	67.66	2757
Ostheim	40.73	3407
Fladungen	46.37	2178
Hausen	24.21	717
Sondheim	18.58	959
Sandberg	28.04	2561
Wildflecken	77.56	3052
Riedenberg	13.22	970
Großer Auersberg	4.68	0
Geroda	16.79	901
Burkardsroth	69.11	7640
Hessen		
Ehrenberg	40.81	2547
Hilders	70.38	4655
Gersfeld	89.37	5531
Sum zones E1+E0	873.6	51639
Percent accepted	85.5	86.4

Table 8.1: Municipalities in starlight buffer zone E1: Municipalities with red numbers have not yet voted on the guidelines, with red background have declined (Birx).

The lighting guidelines (see appendix) give simple but effective rules for dark sky compliant lighting:

- In future only full cut-off (ULR=0% or – even more sharply - lighting class G6) luminaires shall be installed.
- Lamps with high efficiency and color temperatures below 3000 K shall be used as ecological light sources with low content of blue light.
- Illuminances must not be brighter than 2 cd/m², self-illuminating signs not brighter than 50 cd/m².
- Maximum illumination level for streets shall not be higher than 10% over the levels recommended in norm DIN/EN 13201. This upper value was agreed on during European IDA meetings in Genk and Brussels (2005). From a juridical point of view lower values than those defined in the norms cannot be recommended though in practice levels in use are mostly much lower than specified by the norm.
- Reducing the light during the night (total or partial switch-off, illumination on demand, illumination with motion sensors) between 23:00 and 5:30 is recommended.
- Using a bright pavement (concrete) will also allow using lower illuminance values.

Communities in the Biosphere Reserve have already demonstrated their willingness to reduce light pollution by applying the lighting guidelines for new installations or replacements. This will be shown by the examples which have been planned during the application process since 2011-2014.

Outer Starlight Buffer Zone E2

The rest of the Biosphere Reserve is within the outer buffer zone with less strict regulations than zone E1.

The lighting guidelines are less strict (compared to zone E1) in a few points:

- ULR can be up to 3% in built up areas where the light is blocked by buildings (mainly city centers)
- Illuminances must not be brighter than 5 cd/m², self-illuminating signs not brighter than 100 cd/m²
- Switch-off is recommended between 24:00 and 5:00.

	Area [km ²]	Inhabit.
Biosphere Reserve	1865	
E2-Kommunen		
Thüringen		
Oepfershausen	12.26	486
Friedelshausen	6.91	314
Hümpfershausen	13.26	418
Schwarzbach (Schwallungen)*		350
Wasungen* ???	29.5	3467
Wahns*	8.01	430
Mehmels*	6.46	349
Rippershausen*	11.49	871
Walldorf*	12.16	2196
Wallbach*	5.07	366
Roßdorf	17.28	678
Empfertshausen WAK	4.87	592
Klings WAK	6.51	464
Fischbach WAK	7.02	555
Kaltenlengsfeld WAK	9.73	416
Kaltenordheim WAK	15.61	1712
Herpf (Meiningen)	18.08	918
Sülzfeld*	17.39	863
Diedorf	4.75	373
Wiesenthal*	13.57	788
Neidhartshausen	7.59	334
Zella	1.71	267
Brunnhartshausen	10.59	378
Gerstengrund	4.58	63
Oechsen	12.49	649
Buttlar	21.27	1323
Geisa	71.75	4675
Schleid	30.39	1025
Hessen		
Hofbieber	87.2	5990
Dipperz	30.05	3302
Nüsttal	45.5	2830
Rasdorf	30.07	1632
Ebersburg	37.05	4480
Poppenhausen	40.77	2536
Tann E1	60.45	4430

	Area [km ²]	Inhabit.
Bayern		
Motten	23.8	1756
Stockheim	19.86	1135
Nordheim	16.56	1105
Willmars	12.17	589
Bastheim*	41.75	2126
Schönau	15.58	1260
Schondra*	28.61	1730
Mellrichstadter Forst	4.14	0
Burgwallbacher Forst	16.18	0
Forst Schmalwasser-Nord	1.69	0
Forst Schmalwasser-Süd	14.31	0
Steinacher Forst	19.85	0
Römershager Forst-Ost	3.76	0
Waldfensterer Forst	11.31	0
Geiersnest-Ost	19.63	0
Oberleichtersbach	27.6	2026
Bad Brückenau	23.73	6462
Sum zone E2	1011.92	68709

Tab. 8.2: Municipalities in buffer zone E2. Municipalities with red numbers have not yet voted on the guidelines, with red background have declined (Geisa).

The municipalities lying in the E2 zone are listed in table 8.2.

Most communities (85.5% of the areas and 86.4% of the population) within the core and buffer zone E1 have adopted the guidelines and therefore will effectively protect dark skies within the core zones in the future (status Mai 2014).

Referring to the whole Biosphere Reserve, communities with 67 % of the area of the Biosphere Reserve and 69% of the population have formally adopted the lighting guidelines till May 2014. The process is ongoing, further municipalities will vote on the lighting guidelines in the months after writing the application and it is expected that further communities will adopt the guidelines.

A special case are some municipalities in Thüringen, as there was a massive opposition against changes in zonation of the Biosphere Reserve (Jedicke, 2013) which seems to have been transferred to the zonation scheme of the star park, as some municipalities (Birx and Geisa) decided to not support the project for now. This might be due to the fact that there was not enough information given to these villages. Therefore in the next months more information and talks will be given to the communities and their population on the star park hoping that they also will adopt the guidelines – especially as the state Thüringen has a long tradition in astronomy!

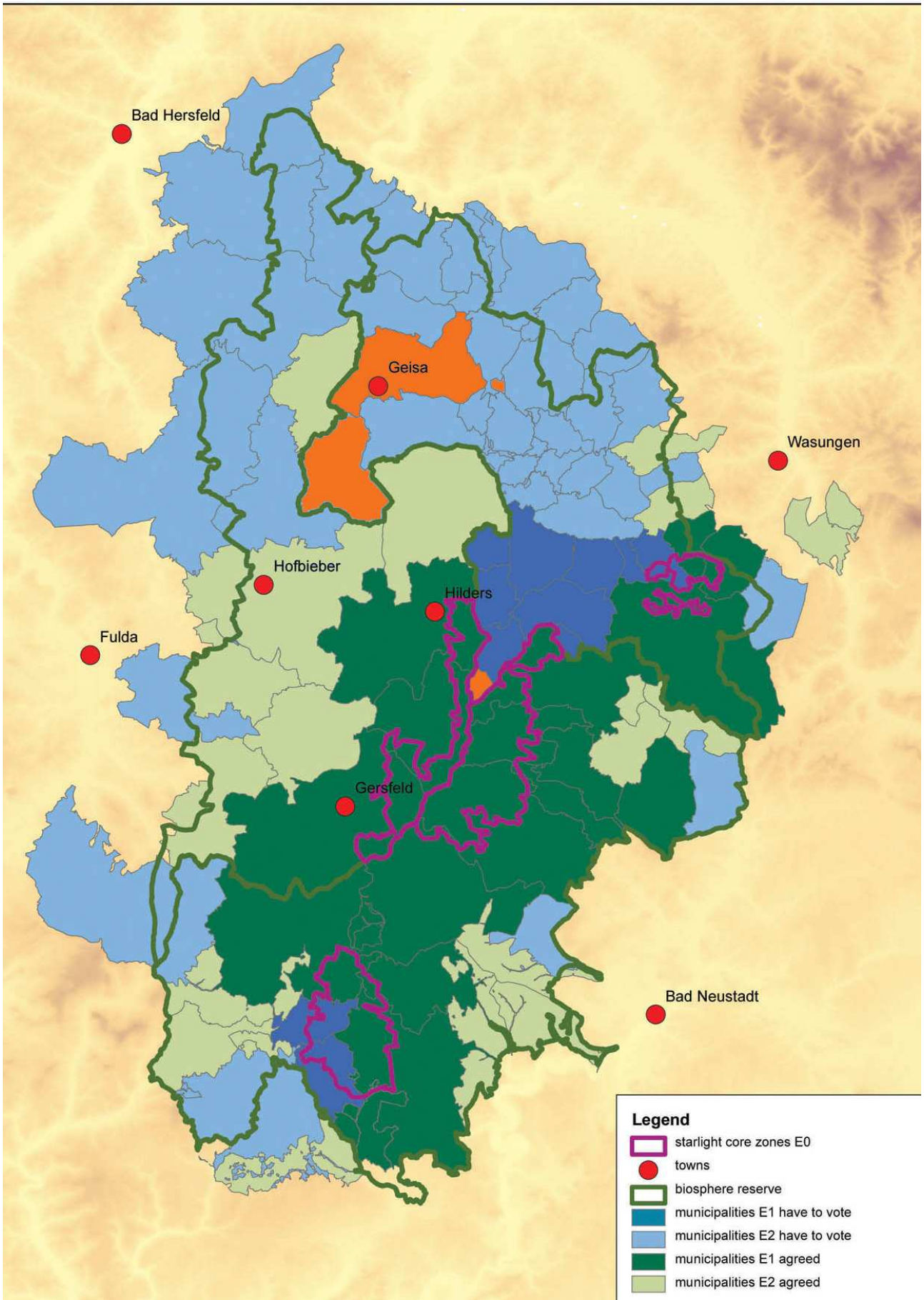


Fig. 8.2: Municipalities in the Rhön Biosphere Reserve: purple line: starlight core zone E0, dark green line: boundary Biosphere Reserve. Dark green areas are the municipalities in E1, bright green areas municipalities in E2 that accepted the guidelines, dark blue are municipalities in E1 that should, bright blue are municipalities in zone E2 that should vote on the guidelines. Red are municipalities that voted against.

9 Modifications in the Biosphere Reserve

Already during the preparatory process for installing the star park a lot of bad lighting installations were removed or changed to dark sky friendly illumination.

Modifications in buffer zone E1

1. Environmental education center Schwarzes Moor

The artificial outdoor lighting at the environmental education center has simply been removed as it was not used anyway, though they were expensive designer luminaires. The fluorescent tubes in the building are shielded through the roof and used only very occasionally.



Fig. 9.1: Outdoor lighting at the environmental education center, which has been removed.

2. Rhöniversum

Mainly brightly illuminated windows shine into the night, the flood lights at the parking lot will be exchanged.



Fig. 9.2: Lighting at the Rhöniversum

3. Quarry Seiferts

The light at the entrance is controlled by a motion sensor, but the bright lights in the quarry were on during night. The director agreed that the lighting will generally be switched off after the end of working hours, which only occasionally last till 21:30 in summer. A check in March 2014 showed that it is true.

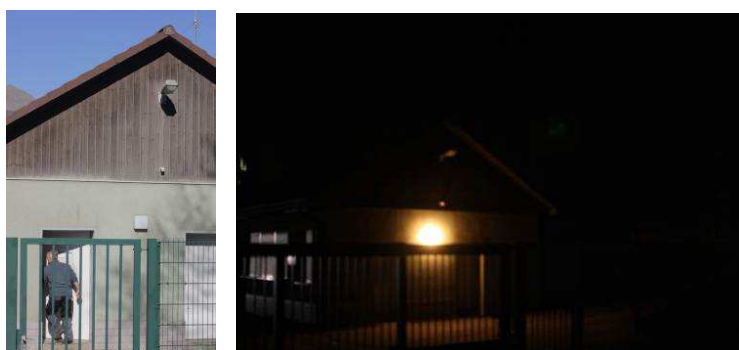


Fig. 9.3: Lighting at the entrance of the quarry



Fig. 9.4: Lighting within the quarry

Modifications in buffer zone E1

4. Wasserkuppe

The Wasserkuppe is the highest mountain in the Biosphere Reserve and was used as military radar and surveillance station to explore eastern Germany till 1989. The area was illuminated with security lighting that was visible at large distances. This has been removed completely in 2010 – ever since then the mountain top is dark and the project star park will help that it remains dark.



Fig. 9.5: Left: Wasserkuppe in 2004 with security lighting (photo: *Norbert Demel*), right: In 2011 only a red security lighting (switched off in the meantime) was on the radar dome and clouds illuminated from villages.



Fig. 9.6: Entrance lighting of the Biosphere Reserve administration building Hessen was switched on the whole night and has been retrofitted with motion detectors.

As in the near future the parking lot on the Wasserkuppe will be renovated, new installations are planned for pedestrian crossings. Originally luminaires with lighting levels of 25 lx, LED with cct 4000 K and whole night use were planned. After invention from the star park protagonists, only full cut-off luminaires will be installed with yellow LED with cct <2000 K and lighting levels of 9 lx. They will be switched on only during winter and be reduced (down to 10%) during the night. They will be installed in summer 2014 and shall become a demonstration project for environmentally friendly lighting.

5. Oberelsbach

The original decision was to replace all lamps in Oberelsbach with LEDs with cct 4000 K. But strongly arguing for the requirements of the star park a final decision was agreed for LED replacement kits or new luminaires with 3000 K cct. In total **526 luminaires** have been replaced in Oberelsbach and the districts belonging to the municipality. The total amount of light has been reduced by about a factor of 3.6.

Furthermore, they are dimmed during the night (0:00 – 5:30) to 40 – 35% of the normal light amount. And the upward light is reduced considerably. It is estimated that 80% of energy is saved compared to the old mercury installation!



Fig. 9.7: Old HQL lighting in Oberelsbach (left side) has been replaced by 3000 K LED (right side). In the top left picture, in the right side a luminaire with a test LED kit with 4000 K was installed. The pictures on the right were taken using double exposure time (1/10 s) compared to the pictures on the left (1/20 s)



Fig. 9.8: left: Old whip luminaires with fluorescent tubes, right: new 3000 K LEDs (same exposure values!)

6. Hausen

The town of Hausen plans to exchange the sodium high pressure lamps by LED lamps in the lanterns. A first test installation shows that the light is much better directed to the ground.



Fig. 9.9: Left: test retrofit installation with a LED module mounted in the roof of the lantern. Right: a conventional sodium high pressure lamp with high ULR.

7. Brüchs

The illumination of the church in Brüchs could be seen at many places in the Rhön, as it is very badly adjusted. It was illuminated with two 400 W floodlights throughout the night and was even visible on satellite images. After an informal conversation with the mayor and the head of the parochial church council, the illumination of the church is switched-off at 22:00. Further adjustments of the illumination are planned.



Fig. 9.10: Badly adjusted illumination of the church in Brüchs illuminates the sky.

8. Bischofsheim, switch-off

In 2013 the town of Bischofsheim (1700 inhabitants) decided to switch-off the public lighting in the outskirts of the village at midnight due to the bad financial situation of the community, but also to sustain the star park. The lighting in the town center stayed on.



Fig. 9.11: Bischofsheim: switch-off at midnight in the outskirts, while in the center lights remained on (covered on the right by the trees).

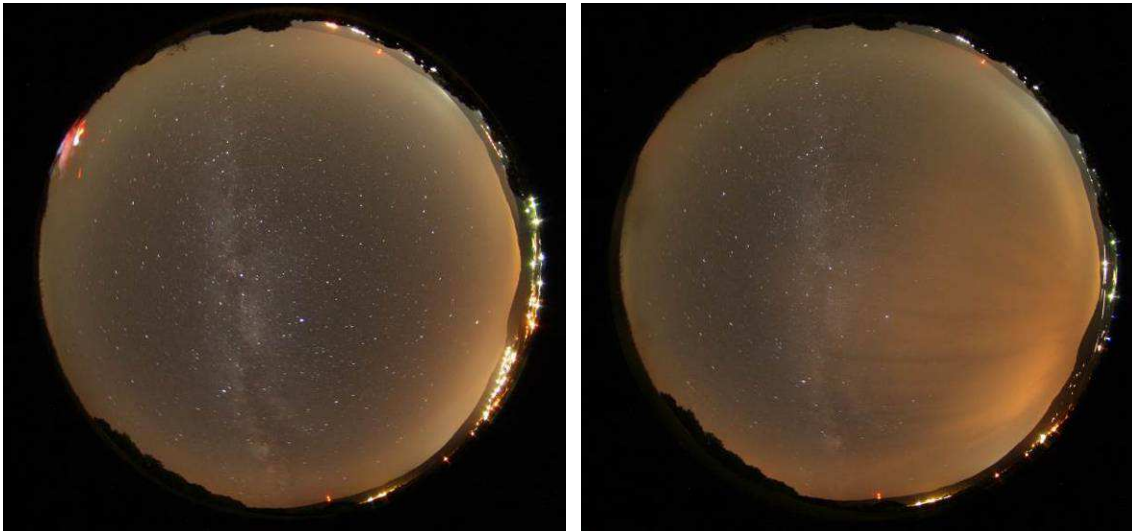


Fig. 9.12: It was tried to document if a reduction in sky brightness might be visible. After midnight clouds came up, so that the all-sky images cannot give a clear picture.

It is not known how many luminaires were switched off, but many luminaires, that are not very well shielded, remained illuminated. Therefore the reduction of the sky brightness was less than 0.1 mag/arcsec^2 . It seems that either the total amount of light in the village (estimated at 2 Mlm) is relatively low or that the amount of light that was switched off is low. It seems, that a better shielding of the luminaires might achieve a better effect reducing the sky brightness. Finally the switch-off had to be abandoned as citizens and politicians were not happy with it. The city is now considering another concept to reduce the amount of light during the night.

9. Fladungen

The town of Fladungen (1200 inhabitants) also switches off part of the public light, though it is not known at exactly what time. At 23:15 it was still on, at 1:00 it was partially switched-off.



Fig. 9.13: Partial switch-off in Fladungen, top at 23:15, bottom at 1:00. Some outside settlements are switched off completely. Dominant is the glow of the bad illumination of the church of Brüchs on the horizon.

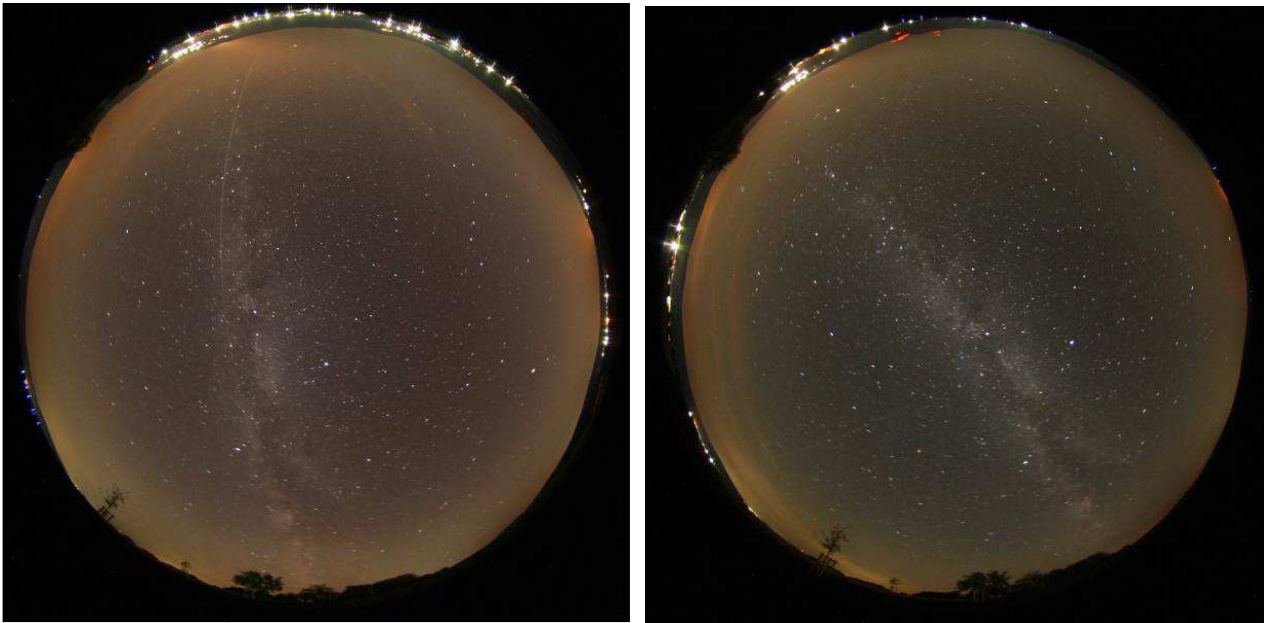


Fig. 9.14: The comparison of the pictures taken at 23:15 (left) and 1:00 (right) showed some reduction of the sky brightness. This might be due to changes in the atmospheric conditions or partly to the partial switch-off in Fladungen. Better atmospheric transmission or switch-offs towards the south (bottom) seems also to reduce the sky brightness.

Measurements showed that the sky brightness was reduced by about 0.1 mag/arcsec^2 .

In Fladungen the former forge “Fuchs” produced luminaires which are installed in many villages of the region Franken. They were used with high pressure mercury bulbs, later with sodium high pressure or compact fluorescent lamps (fig. 9.15). They all have a high upward light flux (estimated 25%) as can be seen on the walls of houses standing behind the luminaires in fig. 9.16.

It was intended to renovate these luminaires by just exchanging the lamps with LED lamps which would not have changed much the upward flux. To reduce the upward light output it was finally decided to install a circuit board (Bergmeister Leuchten) in the roof with 3000 K LEDs that will direct the light downward and only reflections and stray light from the glass produces some upward light (estimated up to 3%, fig. 9.17). This solution is however 3 times more expensive than just changing the lamp. 6 test installations have been put up in Fladungen and later the city and others will decide how they will replace the old luminaires.



Fig. 9.15: The Fladungen luminaire was used with different kinds of lamps (left: 2 CFL with 16 W, then sodium high pressure with 68 W, and these were changed through the door (right))

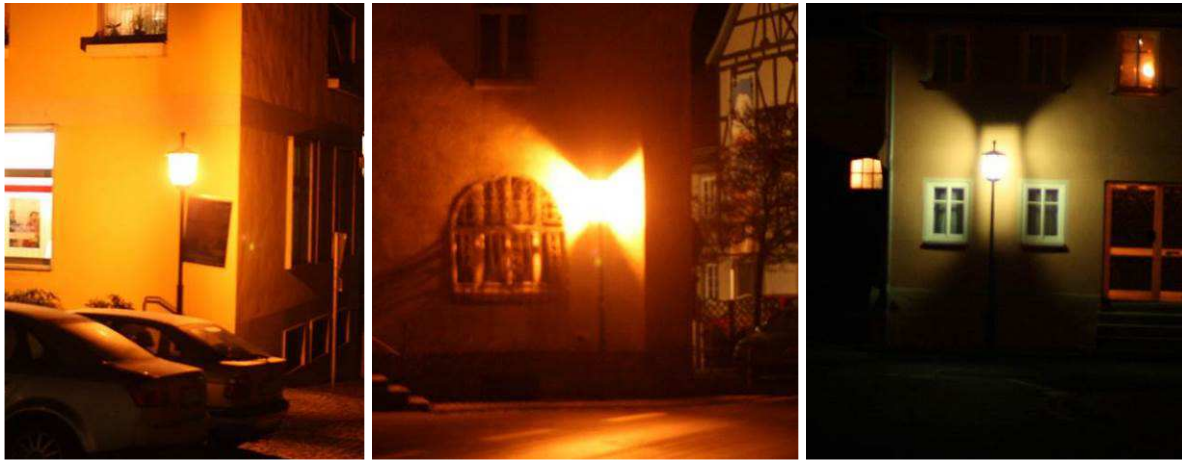


Fig. 9.16: The light distributions on the walls show that much light is emitted above the horizon.



Fig. 9.17: With the renovation a LED board was installed in the roof of the luminaire. There is only little upward light and most of the light is emitted downwards.

10. Hilders

This town tried to switch off the light during late night hours, but the citizens complained about this. The light was switched on again, but in many (90) luminaires only one of the two normally installed fluorescent tubes is used, reducing the amount of light by 50%. Only at crossings or at the school 2 tubes are still used as it is thought that there more light gives more security.



Fig. 9.18: Luminaires in Hilders are mostly equipped just with one fluorescent tube instead of two.

11. Dipperz

In the town of 22 new luminaires shall be installed in a new residential area. They selected LED luminaires are full cut-off, but the cct was neutral white 4150 K. When the mayor learnt that only warm white would fulfill the requirements for the star park, he changed the order to warm white LED which the manufacturer offers at 3500 K.

12. Lighting demonstration street in Fulda

RhönEnergie, an important local energy supplier, has installed in Fulda a test road for lighting. They put up 3000 K LED lamps but also an amber LED street lighting (“batlamp” from Innolumnis).

A good cooperation with the energy supplier, who also consults municipalities in the Rhön, began as they recommend to the communities to use full cut-off luminaires with color temperature 3000 K or lower.



Fig. 9.19: The lighting test road of RhönEnergie in Fulda with PC-amber LED lighting



They also made a test installation with motion detectors: normally the light level is at 20%, when a person is passing it turns to full brightness. In addition the lamps are powered by photovoltaic cells (fig. 9.20).

Fig. 9.20: On the left the luminaire at normal reduced light level that is turned to full intensity when a person approaches

10 Public Outreach

Talks and Star Walks

The first introduction of the project idea outside Fulda University of Applied Sciences, where the idea was originally born, took place in the panel of tourism and ecological development of the Hessian sub-board of trustees of the Biosphere Reserve in February 2011. In the following of this first presentation, the Hessian administration of the Biosphere Reserve asked for a feasibility study, which was carried out by *Dr. Andreas Hänel* and *Sabine Frank* of the student group and presented to the same panel in April 2011. Shortly afterwards, the Initiative for the Protection of the Night Sky (Initiative zum Schutz der Nacht) emerged out of the student project group. A small flyer was created and firstly distributed on a booth at the celebration of the 20th year anniversary of the Rhön Biosphere Reserve.



Fig. 10.1: Booth at the 20th anniversary of the Biosphere Reserve (Gersfeld) in Aug 2011 (foto: *Frank*)

In order to get as much support as possible and to sensitize as many people as possible, it seemed very important to the initiative, to reach many different target groups. Therefore the Initiative started contacting various organizations in the proximity and also nationwide. Doing a lot of star walks and astronomical events, where the point of light pollution was always raised, contributed the spreading of the word about the project.



Fig. 10.2: Star talks to the general public (left) and to educate nature guides from all over Bavaria (right)

In December 2011 two members attended the well-respected interdisciplinary conference in Tutzing - "Protecting the night – Schutz der Nacht". The accompanying media was very interested in the Rhön project and together with the publication of a report about the project in the nationwide German press agency (DPA) the topic of protecting the night by establishing a Dark Sky Reserve in the Rhön took off like a rocket and caused a very strong public perception. This was for the Initiative a turning point in general perception and soon many interviews, TV reports and both print and online articles followed. One highlight was certainly the appearance on a live TV show being the only guest and being interviewed in January 2012 ("Alle Wetter" / "All weathers" on the Hessian TV station HR). More reports followed with the absolute highlight being a nationwide half hour long TV documentary broadcasted in March 2014.

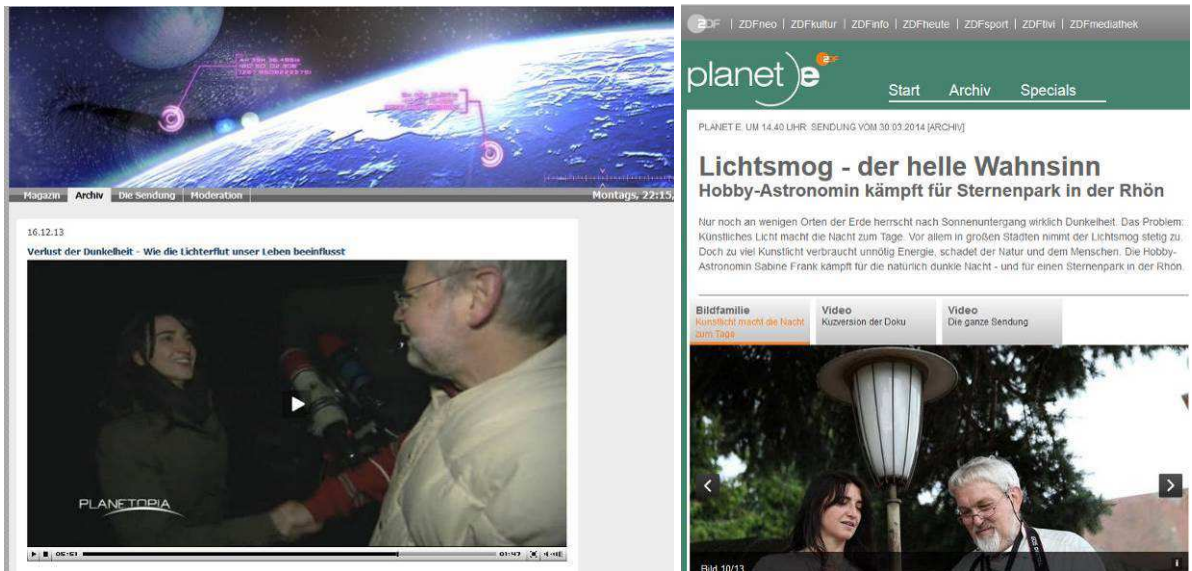


Fig. 10.3: Screenshots of TV emissions about the star park Rhön



Fig.10.4: Many people from the region came to a presentation about the star park in the radom on the Wasserkuppe (left), while another one on the Geba was more in the atmosphere of a mountain hut (right).

Next to lecture talks to the public, the introduction of the lighting guidelines to the elected representatives of the local parliaments is another big part of the work. The implications of artificial light at night are always being conveyed in these hearings. Some parliaments are rather critical about the project as they fear uncontrollable costs or further restrictions in the future. Bearing this in mind, it is important to be very clear about the project and the lighting guidelines. It has turned out, that the acceptance of the lighting guidelines rises when there was a public hearing.

Wo Sternlicht unter Naturschutz steht
Dark-Sky-Parks und ihre Ausweisung

von Andreas Hohl
mit Christian Reuter

Übermäßige und falsche Beleuchtung behindert nicht nur unsere Sicht auf die Wunder des Sternhimmels, sondern stört auch die natürlichen Lebensrhythmen nachtaktiver Lebewesen und trägt zur Verschönerung öffentlicher Gärten bei. Lichtverschmutzung hat dazu geführt, dass man in Europa nur noch sehr wenige Regionen finden kann, in denen noch gute bis sehr gute Beobachtungsbedingungen vorherrschen. Solche Regionen können sich um die Anerkennung als 'Dark-Sky Park' bemühen - und auch in Deutschland gibt es inzwischen erste Bemühungen, derartige Schutzgebiete für den Nachthimmel einzurichten.

✦ **Astronomische Nachtwanderungen in der Rhön** ✦

Sternstreckwanderungen
Mondlichtwanderungen
Keltenerführungen
Vorträge Projekt „Sternpark Rhön“ ✦

Kommt mit...

... auf eine Reise in die Nacht und hört allerlei Geschichten aus Wissenschaft und Mythologie...

Nicht nur bei Tageslicht beeindruckt die Rhön als Kulturlandschaft der offenen Fernen, sondern gerade auch die sternreichen Rhöner Nächte verzaubern den Betrachter. Die Astronomie gilt als die älteste Wissenschaft und kaum eine Kultur konnte sich dem Zauber des Nachthimmels entziehen. Erleben Sie unter freiem Himmel ein fachkundiges astronomisches Programm, indem neben Erklärungen zu himmelsmechanischen Vorgängen auch das Auffinden und die Geschichten rund um Sterne, Sternbilder und Planeten ihren Platz finden.

... denn der Himmel ist voller Geschichten!

STERNENPARK RHÖN

Natur- und Artenschutz
Bildung - Tourismus
Astronomie

Fig. 10.5: Very early the Biosphere Reserve's administration published information material, e.g. a reprint of an article published in the astronomy journal Interstellarium or information leaflets

Generally it is always tried, to not only convey the problems of light at night but also to offer a solution – the lighting guidelines being the instrument for the protection of the night sky. The Initiative therefore promotes the adoption of the guidelines also outside the Rhön. This leads to many invitations from private and public organizations, which are mainly interested in saving energy. Luckily, the Initiative meanwhile has a pool of people, who are able to present the project and explain the guidelines. As one example the environmental education center Rhöniversum Oberelsbach (*Joachim Schneider*) has integrated astronomy courses, star walks and information about light pollution in its regular program.



Fig. 10.6: Students working at the Rhöniversum on the topic of light pollution, left: discussion about the efficiency of light bulbs, right: the influence of artificial lighting on human beings.

Further astronomical activities were offered at nature experience camps at the Bavarian environmental education center Schwarzes Moor. International astronomy activities are also offered at the international astronomy camp which – as before - takes place in the Rhön in summer 2014.

These activities will continue, they will also be intensified, as within the new Regional Development Concept activities of the star park will receive high priority and be incorporated into the environmental education. Education of biosphere reserve rangers in astronomy and light pollution and information material (e.g. flyers, roll-ups, star charts) are planned.

Exhibitions

Further on some exhibitions on light pollution were presented in the biosphere information centers: The exhibition from NABU (Naturschutzbund Deutschland - Nature and Biodiversity Conservation Union) „**Ökologische Stadtbeleuchtung**“ (Ecological city illumination) was shown in the Bavarian information center Haus der Langen Rhön in May/June 2012.

And the exhibition of the working group Dark Sky was shown in Sept./Oct. 2012 at Groenhoff-Haus of the Hessian administration of the Biosphere Reserve on the Wasserkuppe. The opening talk was given by the biologist Prof. Dr. Gerhard Eisenbeis from university of Mainz about the influence of artificial light at night on flora and fauna.

Another very important issue is to maintain contact with the local suppliers of energy, who provide the municipalities with public lighting and who are crucial for the success of reducing light pollution – now and in the years to come. There have already been meetings on several occasions – together with the heads of the administration offices of the Biosphere Reserves Bavaria and Hesse. It is planned to hold another meeting in summer/autumn 2014. It has turned out, that the people in charge at the energy suppliers have an interest in the project themselves as so many communities have adopted the lighting guidelines.

A website for the star park has been installed www.sternenpark-rhoen.de and a facebook account is being looked after by *Robin Riesner*, who designed also a first logo for the star park. Meanwhile the ARGE Rhön has created a logo as a modification of the official logo.



Fig.: 10.7: Internet homepage www.sternenpark-rhoen.de and facebook page Sternenpark Rhön

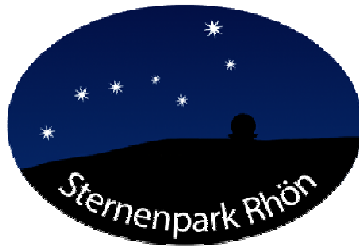


Fig. 10.8: The logo of the star park for the facebook page and the official logo

As a conclusion it can be said, that the topic of light pollution has come of age in the Rhön region and also outside it. Still, there is more work to be done. The current discussion about the so-called energy transition (Energiewende) might support discussion about public lighting in general. Still, for the Initiative's course of PR work the protection and defence of the night sky as well as the nightscapes with all the beings living in it, is of utmost priority.

Tourism and selection of public observing places

The touristic development of the star park was identified as an important and original touristic project within the nation wide roadshow "Touristic Perspectives in rural destinations", which was partly funded by the German Federal Ministry of Economics and Technology. (www.tourismus-fuers-land.de). As a consequence the touristic organizations of the region plan to develop the star park further.

Fig. 10.9: Star Park Rhön as a touristic chance



The Rhön has long been well known for good observing possibilities under dark skies, especially being situated in the center of Germany. And with the publication of the first press articles, people asked at the tourist information centers for observing possibilities. Observing places were identified considering the fragile nature protected areas that must not be disturbed during at night. An information leaflet with observing

These are some of the proposed observing places:



Fig. 10.10: Weidberg (725 m high) and Hohe Geba (751 m).



Fig. 10.11: Parking Schwarzes Moor and Rotes Moor at the border of the darkest and most protected areas



Fig.10.12: Kissinger Hütte on the Feuerberg (829m) in the Schwarze Berge and the southern side of the Wasserkuppe

Especially the Kissinger Hütte (mountain hut for overnight stays) has already managed to attract many amateur astronomers who stay there at moonless nights for astronomical observations.

Sommer

Am 21. Juni um 22 Uhr gehen die Pleiaden und die Hyaden auf. Die Sommersternbilder sind am besten abends im Südwesten zu sehen. Die Pleiaden sind am besten abends im Südwesten zu sehen.

Herbst

Am 21. September um 22 Uhr gehen die Pleiaden und die Hyaden auf. Die Sommersternbilder sind am besten abends im Südwesten zu sehen.

Winter

Am 21. Dezember um 22 Uhr gehen die Pleiaden und die Hyaden auf. Die Sommersternbilder sind am besten abends im Südwesten zu sehen.

Kontakt / Impressum

Sternepark im Biosphärenreservat Rhön
Ein Projekt zum Schutz der Nacht

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Fig. 10.13: Information leaflet about the star park with hints to the observing places.

A new flyer is already in the making and will be released appear in late summer 2014.

11 Conclusions

As described before, we are convinced that the criteria for an International Dark Sky Reserve (DSR) in the Rhön Biosphere Reserve are fulfilled:

Eligibility

- A) The value of the Rhön Biosphere Reserve for nature protection is described in chapter 5.
- B) The DSR core zones have been defined by the darkest regions as determined from the sky brightness measurements and the biosphere core zones (chapter 6)
- C) The core zones E0 cover an area of 145 km² and the buffer zone E1 covers an area of 874 km² and has been defined in a way that allows a reduction of light pollution within the core zones in the future (chapter 6)
- D) Within the DSR core zones and at the borders places for public observations were assigned (chapter 10)
- E) Core night sky brightness corresponds to at least silver tiers (chapter 6)

Minimum Requirements

- A) Lighting Guidelines were adopted by communities in the inner buffer zone (more than 80%) and some in the outer buffer zone E2. As these guidelines were set up in 2012 according to the IDSR guidelines vers. 1.2, they ask for a maximum output of 1000 lm for unshielded light. As the process of voting in the municipal parliaments had already started when the new guidelines were released, a change was no longer possible. However the requirement of reduced blue light was already fulfilled with a maximum cct of 3000 K. (chap. 8)
- B and C) Lighting and modifications of lighting to compliant lighting are described in chapters 7 and 9
- D) At least one continuous measuring SQM-LU has been bought and will be installed at the weather station on the Wasserkuppe. Further measurements with handheld SQM-Ls will be made in the whole region during observing campaigns.
- E) The changes to conforming lighting installations are described in chapter 9. Not each participating municipality could complete demonstration projects, as financial resources are very limited and the timescale is too short. Many municipalities voted only during the last half year on the guidelines, the last just some days before the deadline for this application and they even meanwhile switched off their ground recessed spotlights. But more projects are planned and financial support could become available through the new regional development plan. Within the inner buffer zone E1 some 650 luminaires were replaced by dark sky compliant ones, for some 600 more the light amount was reduced by about 40% by switching them off, corresponding to about 20% of lighting inventory. More communities are considering reducing the burning time of the public lighting.
- G) Public educational programs and the nationwide reaching media coverage are described in chapter 10.
- H) The acknowledgement of the protected area by higher level (the ministers) is documented in the support letter from the ministry (chapter 4).

References

- Biosphärenreservat Rhön 2008: Erster integrierter Umweltbericht für das länderübergreifende UNESCO Biosphärenreservat Rhön
- P. Cinzano, Falchi, F., Elvidge, C. D., Baugh, K. E. (2000): The artificial night sky brightness mapped from DMSP satellite Operational Linescan System measurements. *Mon. Not. Roy. Astr. Soc.* **318**, 641-657
- A. Hänel (2006): The increase of light pollution in Central Europe as documented in satellite data, Proceedings of the Dark Skies Symp. Portsmouth, 2006
- A. Hänel (2013): Leuchtenempfehlungen zur Reduzierung von Lichtsmog in geschützten Gebieten (Recommandation for luminaires to reduce light smog in protected areas)
- A. Hänel (2013): Practice of public lighting in proposed German Star Parks, poster conference "The bright Side of Night", June 2013, Erkner
- M. Held, F. Hölker, B. Jessel (ed.) (2013): Schutz der Nacht – Lichtverschmutzung, Biodiversität und Nachtlandschaft, BfN-Skripten 336
- E. Hovin, U. Schaffner, P. Bergold, V. Bankmann, S. Frank: Biosphärenreservat Rhön - zwischen Himmel und Erde. Hochschule Fulda, 2011
- Jedicke, E.(ed.): Report for the periodic review of Rhön UNESCO Biosphere Reserve 2013
- C. Kyba, T. Ruhtz, J. Fischer, F. Hölker: Cloud Coverage Acts as an Amplifier for Ecological Light Pollution in Urban Ecosystems. 2011, PLoS ONE 6(3):e17307.doi:10.1371/journal.pone.0017307.
- Luginbuhl, C., Lockwood, W., Davis, D., Pick, K., Selders, J.: From the ground up 1: Light Pollution Sources in Flagstaff, Arizona, *Publ. Astron. Soc. Pacific*, **121**, 185-203
- F. Patat: Night sky brightness at ESO-Paranal, *Astron.&Astrophys.* **400**, 1183-1198 (2003)
- T. Posch et al.: *Das Ende der Nacht*, Wiley-VCH, Weinheim, 2010, 2013
- Narissa, K., Schreuder, D, 2004 *Light pollution Handbook*, Springer, Dordrecht
- Starlight Initiative (2009): *Starlight Reserves and World Heritage – Scientific, cultural and environmental values*, Fuerteventura
- Verein „Natur- und Lebensraum Rhön“: Regionales Entwicklungskonzept Lebensraum Rhön 2007-2013, Okt. 2007, Gersfeld
- Westhavelland; *Application of the Nature Park Westhavelland as an International Dark Sky Reserve*, 2013