RANEPA
THE RUSSIAN PRESIDENTIAL ACADEMY OF NATIONAL ECONOMY AND PUBLIC ADMINISTRATION

IARIA

# NIGHT TIME LIGHTS DATA AND SOCIO-ECONOMIC APPLICATIONS

Alexander Troussov, Ph.D.
E-mail: troussov@gmail.com

ComputationWorld 2020 Congress
October 25-29, Nice, France

# AGENDA

- Introduction
  - Night-time lights
  - Examples of applications
- Data and methods of data processing
- Categorization
- Additional examples of applications

# ALEXANDER TROUSSOV

Dr. Alexander Troussov is Director of the International Research Laboratory for Mathematical Methods for Social Network Mining at the Russian Presidential Academy of National Economy and Public Administration (RANEPA) and Head of the Earth Remote Sensing Unit at RANEPA. Former Chief Scientist of IBM Dublin Center for Advanced Studies (2000-2013), one of the creators of the major IBM linguistic technology LanguageWare, and leader of IBM team participation in the three-year integrated 6th framework EU project NEPOMUK (development of a social semantic desktop), he has published more than 40 peer reviewed journal and conference papers and has 8 patents.

His research interests include data mining, earth remote sensing, natural language processing and social networks algorithms.

# ALEXANDER TROUSSOV

- 2014- : Director of the International Research Laboratory for Mathematical Methods for Social Network Mining at RANEPA
- 2000-2013: IBM
  - Architect of IBM LanguageWare
  - Chief Scientist of IBM Dublin Center for Advanced Studies
  - EU Projects

  See http://atroussov.com/
- National Geophysical Data Center, Boulder, CO, USA - Visiting scientist
  - Earth Remote Sensing, numerical databases
- Observatoire de la Côte d'Azur, Nice, France – Visiting scientist
  - Numerical simulation of turbulence
- Institute of Physics of the Earth (Russian Academy of Sciences) and the International Institute for Earthquake Prediction Theory and Mathematical Geophysics, Moscow, Russia – Lead Researcher
  - R&D in geophysics and geoinformatics
- Ph.D. in Pure mathematics from Lomonosov Moscow State University

# Chernobyl 1999

EU-UNESCO workshop, organised within the EU funded project for Support for Telematics Applications Cooperation with the Commonwealth of Independent States (STACCIS)

In this photo you can see Alexander Troussov (STACCIS telematics application engineer, first from the left), Jean Bonnin (Professor of Louis Pasteur University in Strasbourg) and other scientists near the sarcophagus covering the destroyed Chernobyl nuclear reactor.

# NIGHT TIME LIGHTS DATA AND SOCIO-ECONOMIC APPLICATIONS

Alexander Troussov, RANEPA, Moscow, Russia.

Multispectral nighttime remote sensing of the Earth, nowadays commonly referred to as Night-time Lights (NTL), is a rapidly developing subfield of the Remote Earth Sensing. In contrast with the daytime satellite imagery, it focuses on the capturing of the direct radiation, not on the light, reflected by the surface. Therefore, NTL is the most suitable tool to register such typical traces of industrialized societies as high temperature manufacturing and the artificial lighting. It is also a useful tool to monitor environmental issues. Nowadays, the usefulness of NTL data as a good proxy measure for economic activity is recognized in the papers of renown economists and publications of World Bank.

To what extend the nature of the science is determined by the character of the research methods or dominant data used? New data = New science? Whatever the answer is, it is clear that NTL can provide a transformative effect on many areas of socio-economic applications. We concur with the opinion of a renowned physicist Freeman Dyson “The great advances in science usually result from new tools rather than from new doctrines”. In particular, we are interested in tools that are required to support socio-economic applications using NTL and related data.

In general, NTL data can be fit into the concept of the Big Data. Correspondingly, one can assume, that the methods of statistics and machine learning will play ever increasing role. Nevertheless, “new data” invite considerations on the applicability of “old” approaches, and it is suitable to discuss specific aspects of NTL data from the point of view of socio-economic applications. The father of cybernetics Norbert Wiener in his seminal book “Cybernetics: Or Control and Communication in the Animal and the Machine” wrote “I may remark parenthetically that the modern apparatus of the theory of small samples…, does not inspire me with any confidence unless it is applied by a statistician by whom the main elements of the dynamics of the situation are either explicitly known or implicitly felt.” In line with this remark we’ll quickly touch upon the relationships between statistics, statistics of small samples, machine learning and data science. In this talk we’ll also outline gnoseological aspects of NTL data from the point of view of various paradigm of the structure of scientific revolutions.

The substance of the talk is the methods of NTL and socio-economic data mining.

We’ll consider examples of NTL data modelling and analysis of geographically referenced data time series. The proper use of NTL data typically requires data integration with other geocoded data. An important task is the creation of predictive evolution models, particularly using cellular automata (and their generalizations in line with finite-difference methods) and random fields. Tuning of parameters for such models is often an optimization task, and involves machine learning methods, including the use of neural networks and deep learning models. The other topics of the talk include traditional methods of image processing (as well as the use of multispectral images), in application to the automatic classification of terrain

types and vegetation, as well as for the detection and classification of objects related to the oil producing enterprises. The classification task in remote sensing poses big scientific and practical challenges, since dimensionality of data is very high, and the amount of labeled samples is typically relatively small. Therefore deep neural networks for remote-sensing image interpretation will be considered.

Our exposition of methods will be illustrated by the examples of their use in the projects of my laboratory at the Russian Presidential Academy of National Economy and Public Administration, conducted in collaboration with the US National Center for Environmental Information and the Russian Space Research Institute. Direction of our R&D is aligned with the objectives of the UN Sustainable Development Goals. The examples of applications include monitoring of the sustainable development parameters and detection of disasters. Additionally, other related examples also include aspects of oil and gas production, fishery patterns, predictive models of spread of forest fires and growth of urban settlements, which takes into account physical and infrastructural artefacts of the terrain (climate, topography, population, density of road structures).

# NIGHT-TIME LIGHTS

- In contrast to daytime remote sensing, which is generally limited to information on physical characteristics of land cover, night-time light remote sensing (NTL) provides a unique and direct perspective on human activities.
  NTL is a tool for mapping human activities from space.

- Night-time light remote sensing has been widely used in the fields of human geography, demography, economy, sociology, fishery, ecology, light pollution, and human rights. Three groups of scientists in particular are working on urban lights: urban geographers studying urbanization, medical scientists documenting light pollution and its impact, and economists disaggregating or correcting gross domestic product on a local or regional basis.

  Light remote-sensing scientists in developing countries … have tended to focus on urbanization applications, while light-pollution studies are generally undertaken in developed countries.

  The future of night-time light remote sensing appears to be promising, as an increasing number of satellite-borne sensors can record NTL.

*Xi Li, Elvidge, Zhou, Changyong Cao & Warner (2017)*

# NIGHT-TIME LIGHTS

- Remote sensing of night light emissions … offers a unique opportunity to directly observe human activity from space, extending the use of remote sensing to the social sciences. This has allowed a host of applications including mapping urban areas, estimating population and GDP, monitoring disasters and conflicts. More recently, remotely sensed night lights data have found use in understanding the environmental impacts of light emissions (light pollution), including its impacts on human health.

. *Prof. Noam Levin*

# New data – New science?

The great advances in science usually result from new tools rather than from new doctrines.

*Freeman Dyson*

INTRODUCTION

Data

Application examples

Scientometrics

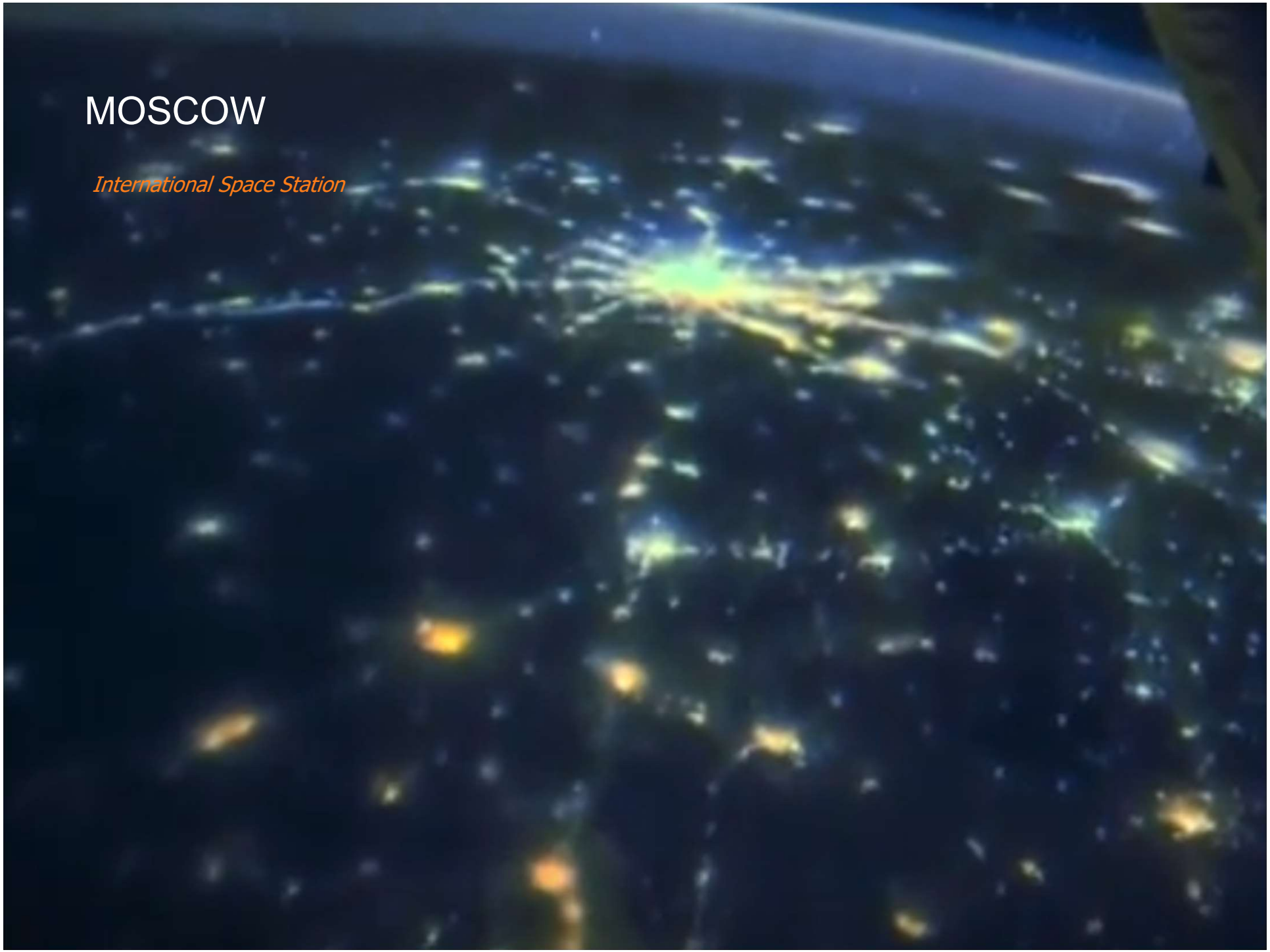
EXAMPLES OF DATA

- Remotely sensed night-time lights (NTL) satellite imagery (American JPSS, International Space Station)
- "Stable Lights" product
- Time series

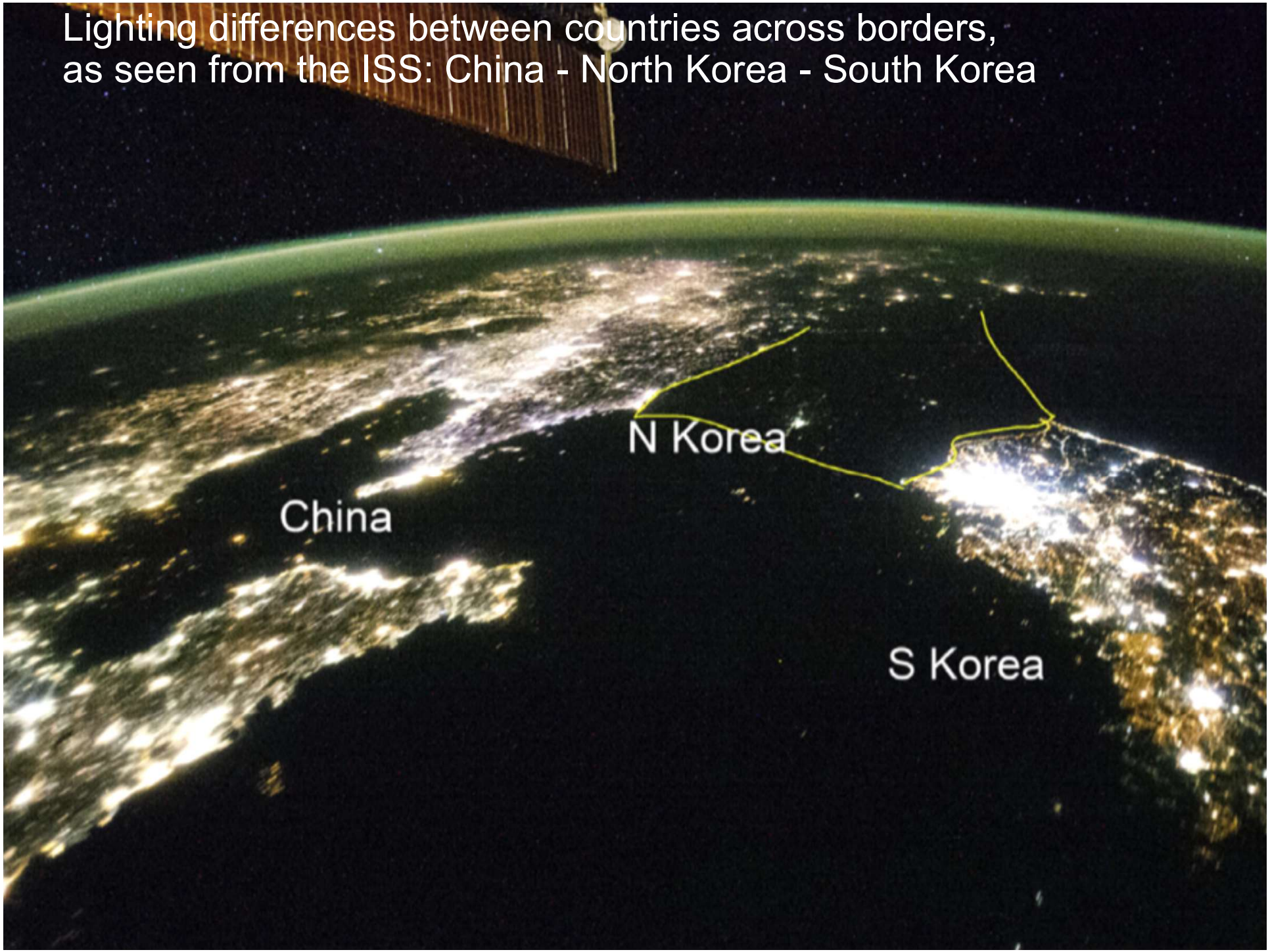
# The Iberian Peninsula, clouds over the Atlantic Ocean (JPSS)

# International Space Station (ISS)

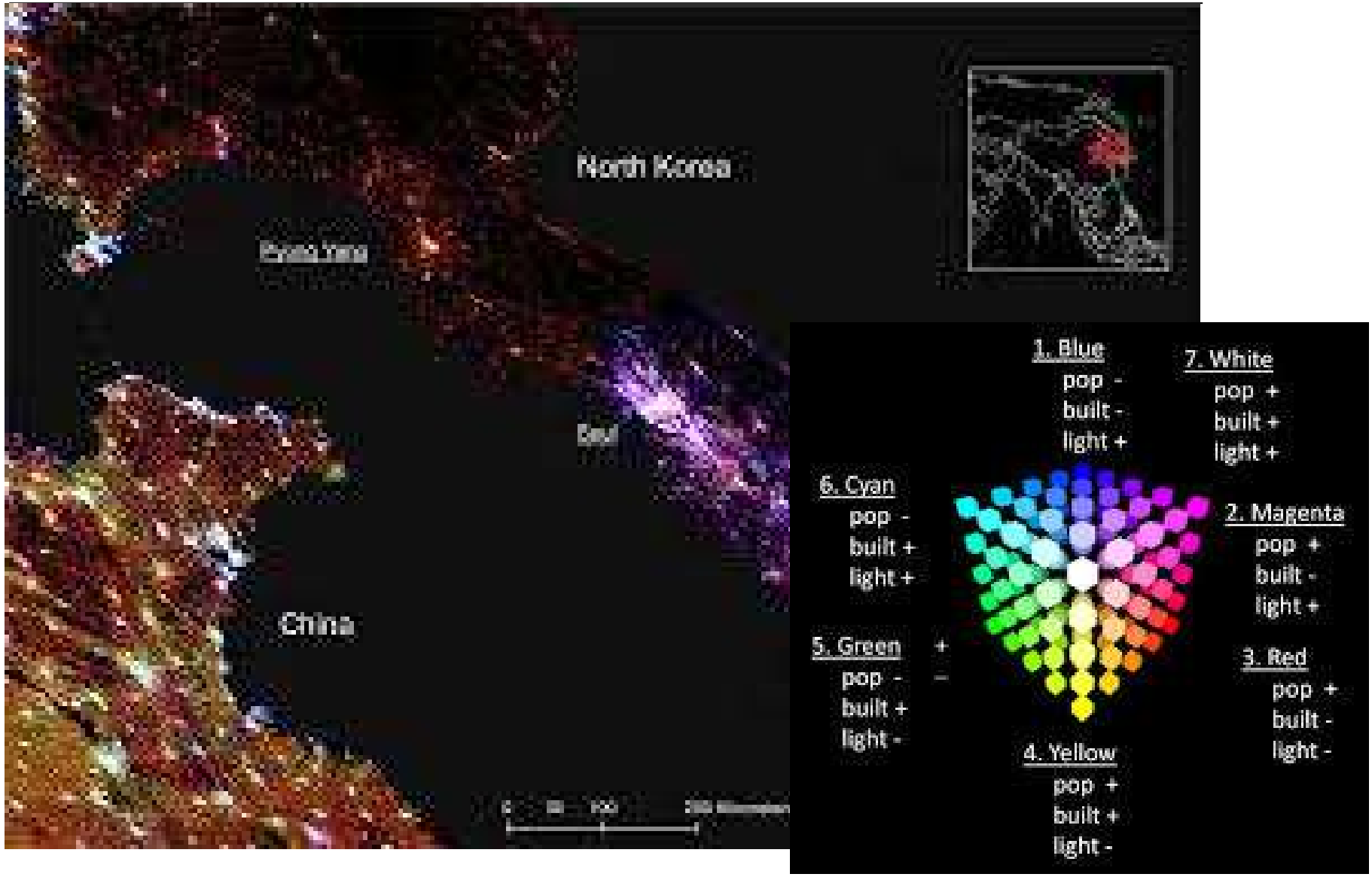

POLAND IS COVERED BY CLOUDS
International Space Station


MOSCOW
International Space Station

Lighting differences between countries across borders,
as seen from the ISS: China - North Korea - South Korea



# Spatial pattern of inequality – a NTL-based map




Night-lit settlement map colour legend based on the colour cube from JRC Publications Repository

# STABLE NIGHT-TIME LIGHTS

Stable Night Time Lights (2015) - a composite image of stable NTL composed of many images cleared from noise and clutter.

# Remark about Night-time Lights (NTL)

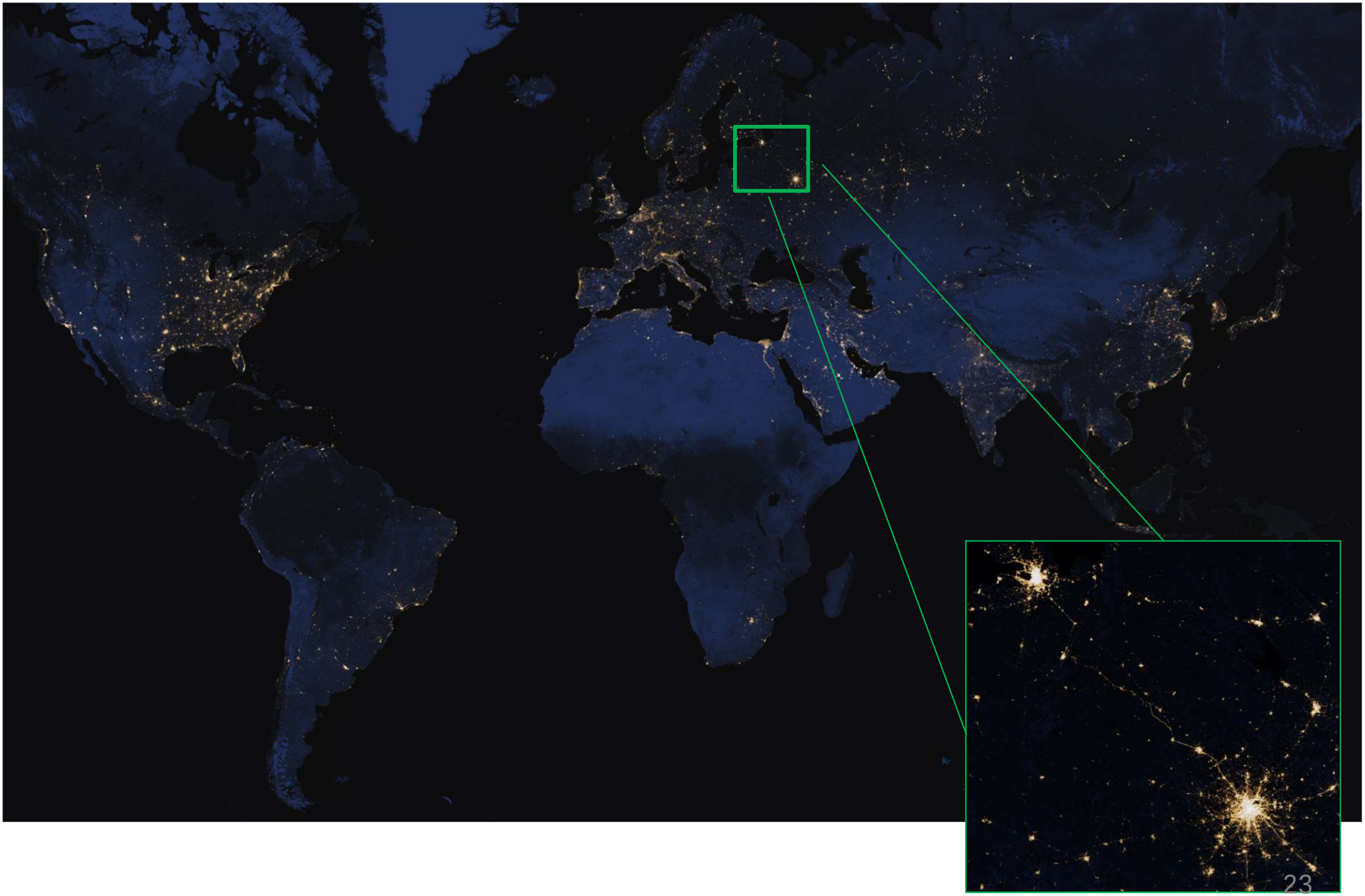
- The most striking observation which can be made from these images is that the Night-Time Lights are distributed highly unevenly.
  - There are megalopolises and cities flooded by light and connected by brightly lit communication lines including roads and roadside settlements and various constructions.
  - Together with this, there are vast dark areas.

  *In my mind's eye, I still have the image of my first night flight in Argentina. It was a dark night, with only occasional scattered lights glittering like stars on the plain. Each one, in that ocean of shadows, was a sign of the miracle of consciousness. In one home people were reading, or thinking, or sharing confidences. In another, perhaps, they were searching through space, wearying themselves with the mathematics of the Andromeda nebula. In another they were making love. These small flames shone far apart in the landscape, demanding their fuel. Even the most unassuming of them, the flame of the poet, the teacher or the carpenter. But among these living stars, how many closed windows, how many extinct stars, how many sleeping men.*

  *Antoine de Saint Exupéry*

- It is evident that there is a strong positive correlation between the brightness of NTL in some areas and the income level of people living there.

# Stable Night Time Lights (2015): Moscow – St. Petersburg

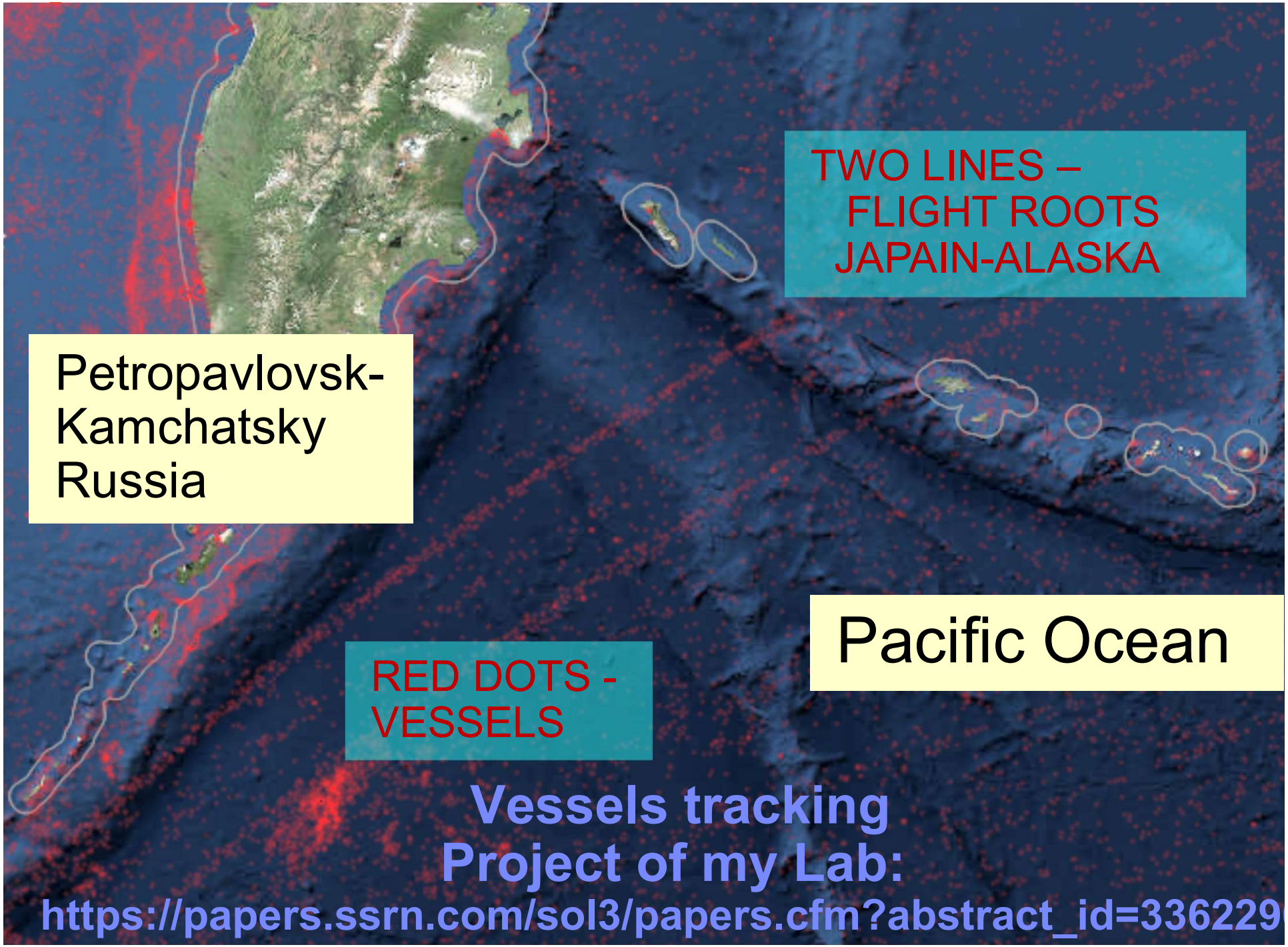


# Stable Night Time Lights (2015): Moscow – St. Petersburg

RANEPA EARTH REMOTE SENSING UNIT
Headed by Alexander Troussov

- DETECTION OF HIGH-TEMPERATURE ANOMALIES
  - Data - multispectral
  - Level of analysis – pixels
  - Methods - Spectral analysis
  - Applications - Detection of gas flares and boats in the sea.
- NIGHT LIGHT EMISSIONS AND SOCIO-ECONOMIC PARAMETERS
  - Data – visual and near infrared composite images
  - Level of analysis – countries, regions, cities, …
  - Methods - Geo-spatial multitemporal analysis of Night-Time Lights (NTL) and NTL trends
  - Applications
    - Proxies for socio-economic parameters
    - Mapping Urban Extent Using NTL


Satellite Monitoring of
Gas Flaring Torches in Russia
Project of my Lab: https://ssrn.com/abstract=3362303


TWO LINES –
FLIGHT ROOTS
JAPAIN-ALASKA
Petropavlovsk-
Kamchatsky
Russia
Pacific Ocean
RED DOTS -
VESSELS
Vessels tracking
Project of my Lab:
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=336229

## Application to the estimation of Gross domestic product (GDP)

- German researchers Julia Bluszcz and Marica Valente in their recent work «The War in Europe: Economic Costs of the Ukrainian Conflict» used the “potential opportunities” approach for estimating the influence of the military conflict in Ukraine on the national GDP. In their work, the researchers evaluate the influence of the military conflict on the national GDP by defining the difference in prewar and postwar GDP rates that are extrapolated to postwar years.
- The authors estimate that, due to the Donbass war, Donetsk’s and Luhansk’s average GRP for 2013-2016 decreased by 43% (4630$) and 52% (3326$), respectively.
- For the period from 2012 to 2018 there is a consistent negative trend in the brightness of urban radiance in the entire territory of military conflicts in the so-called 'Donetsk People's Republic' and 'Luhansk People's Republic’. Using NTL data and non-parametric analysis of trends, we made our estimation of the GDP loss in these two regions.
- Our results perfectly correspond to the results obtained by Bluszcz& Valente (2019).

## Our results perfectly correspond to the results obtained by Bluszcz& Valente (2019).

- Bluszcz& Valente (2019) – econometric models

| | | |
|---|---|---|
| Donetsk: | Decrease in GDP | 43% |
| Luhansk: | Decrease in GDP | 52% |

- RANEPA team (2020) – analysis of Night-time lights (NTL) trends

| | | | |
|---|---|---|---|
| Donetsk: | Decrease in GDP | 40% | (Δ = –3%); |
| Luhansk: | Decrease in GDP | 53% | (Δ = +1%). |

## Our results perfectly correspond to the results obtained by Bluszcz& Valente (2019).

- Bluszcz& Valente (2019) – econometric models

  Donetsk: Decrease in GDP 43%
  Luhansk: Decrease in GDP 52%

- RANEPA team (2020) – analysis of nighttime lights (NTL) trends

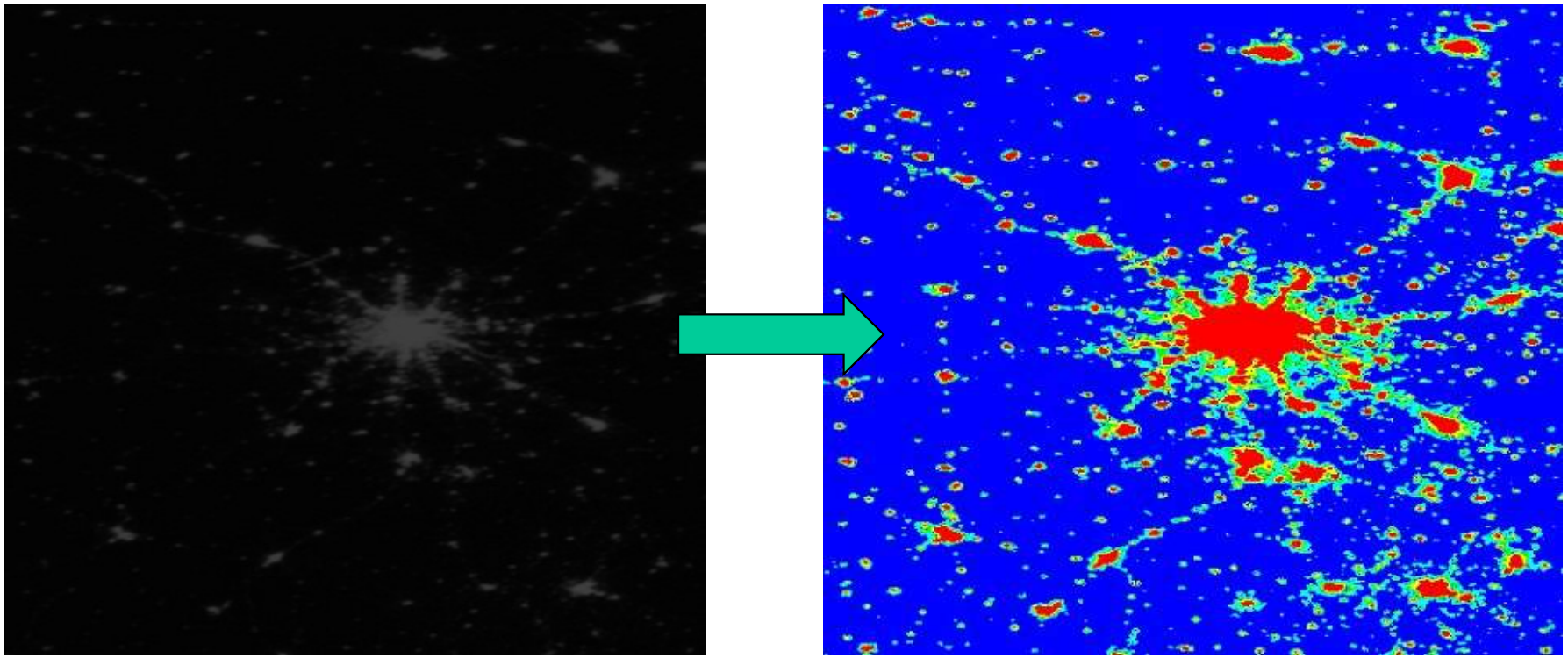
  Donetsk: Decrease in GDP 40% ($\Delta$ = +3%).
  Luhansk: Decrease in GDP 53% ($\Delta$ = +1%).

**STATISTICS**

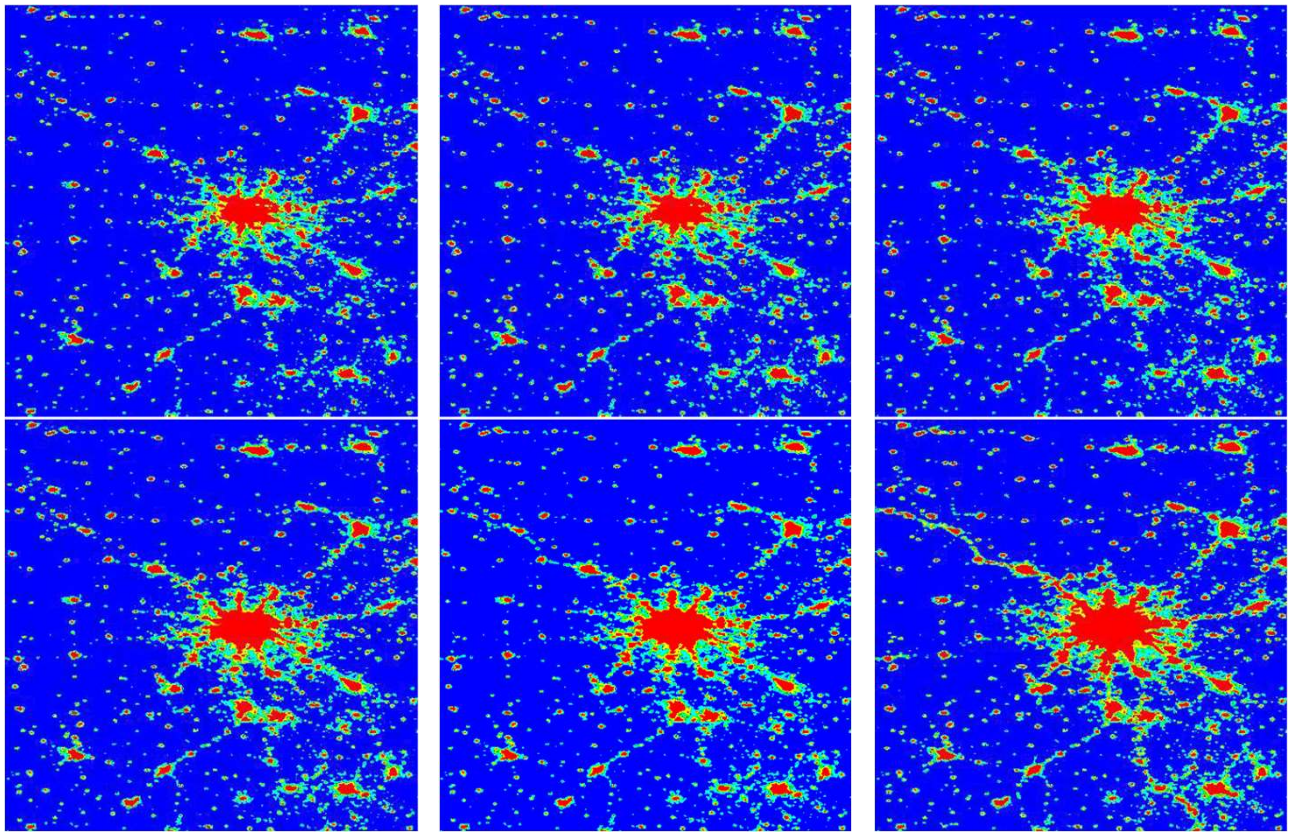
**PHYSICAL SENSOR**

*Data are coherently and logically defined*
*Are registered by the same devise*
*Have global character*
*and the results from different regions can be compared*

# Mapping Urban Extent Using NTL



## Mapping geospatial evolution

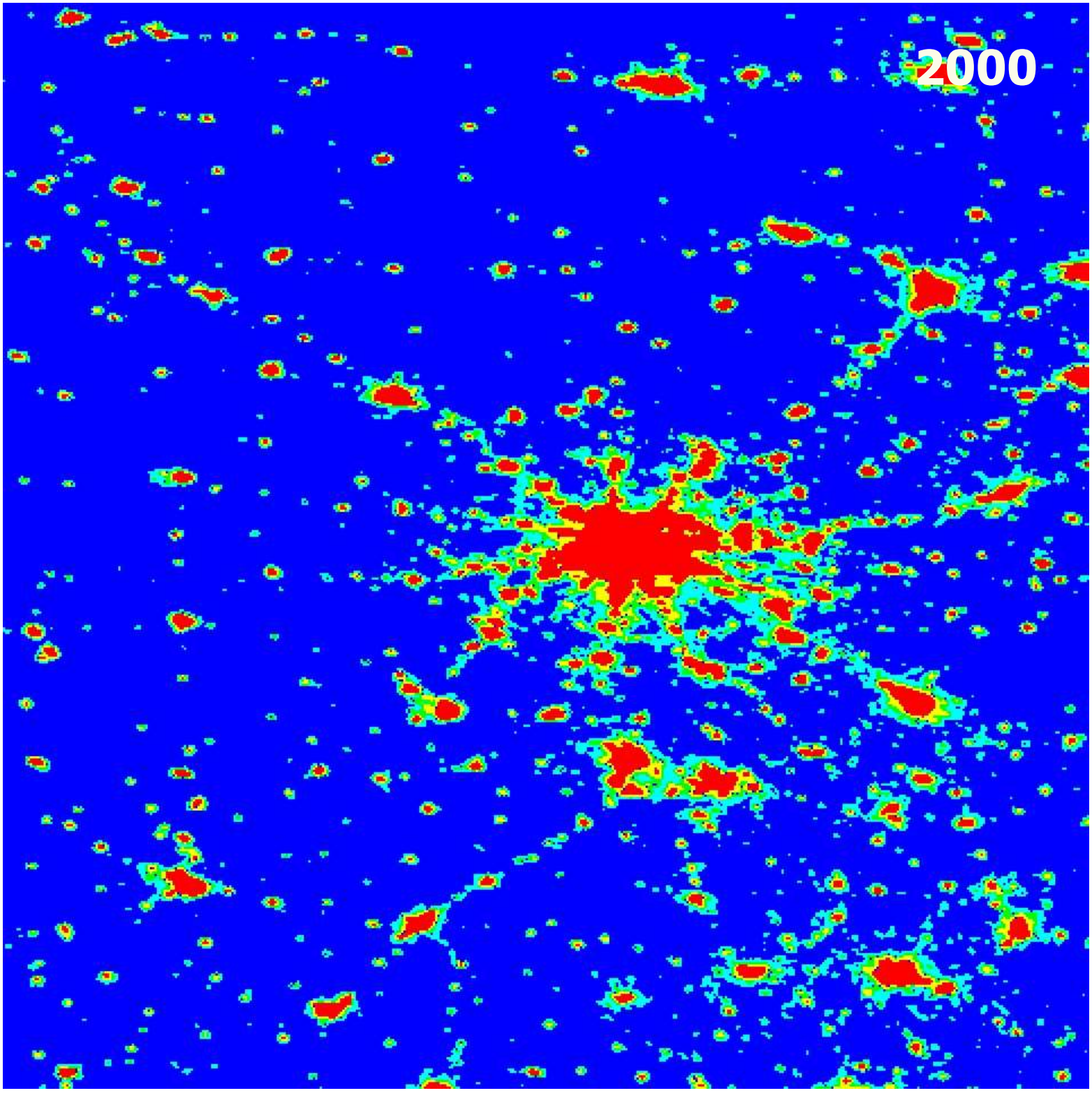


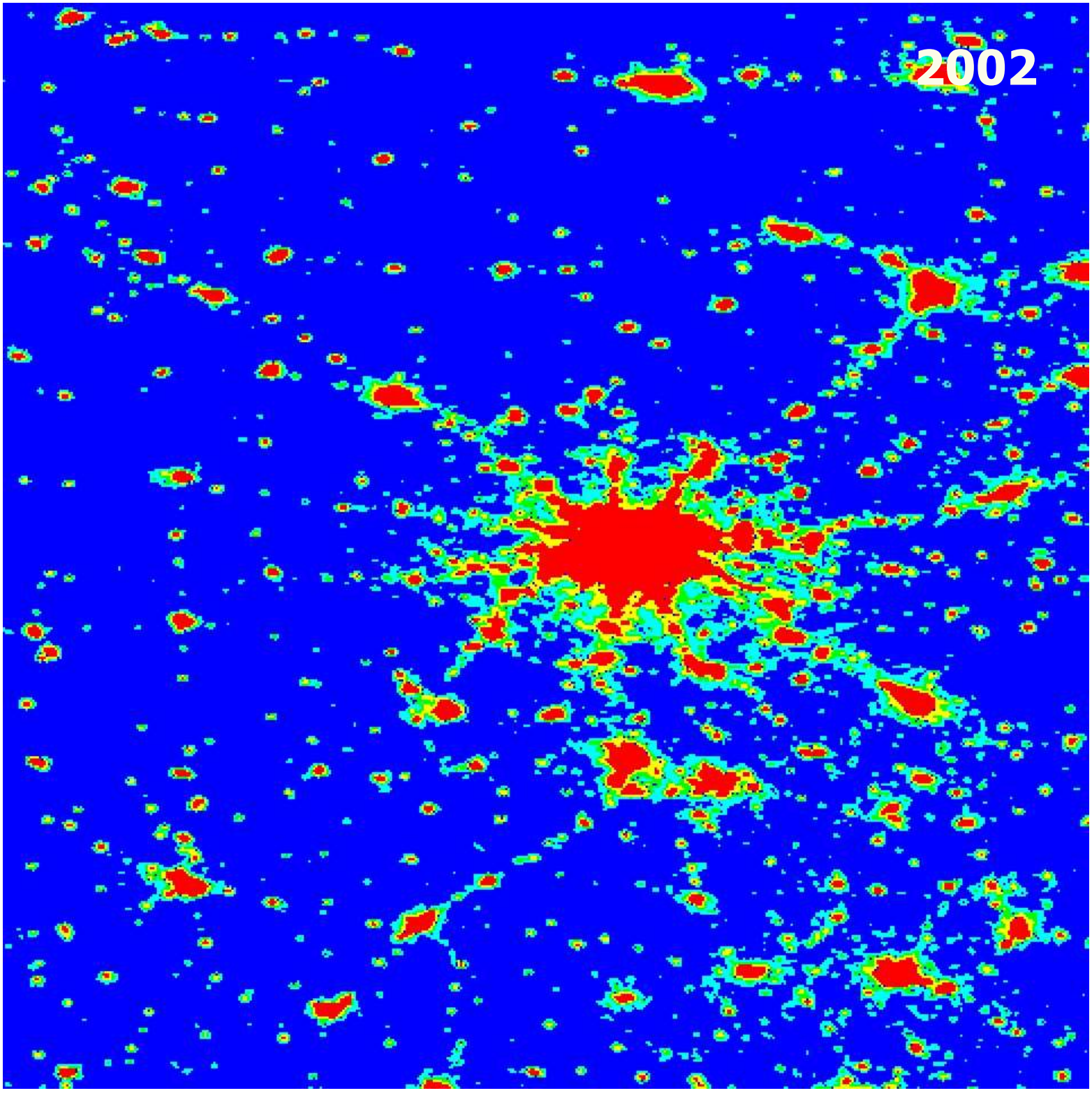
EXAMPLE:

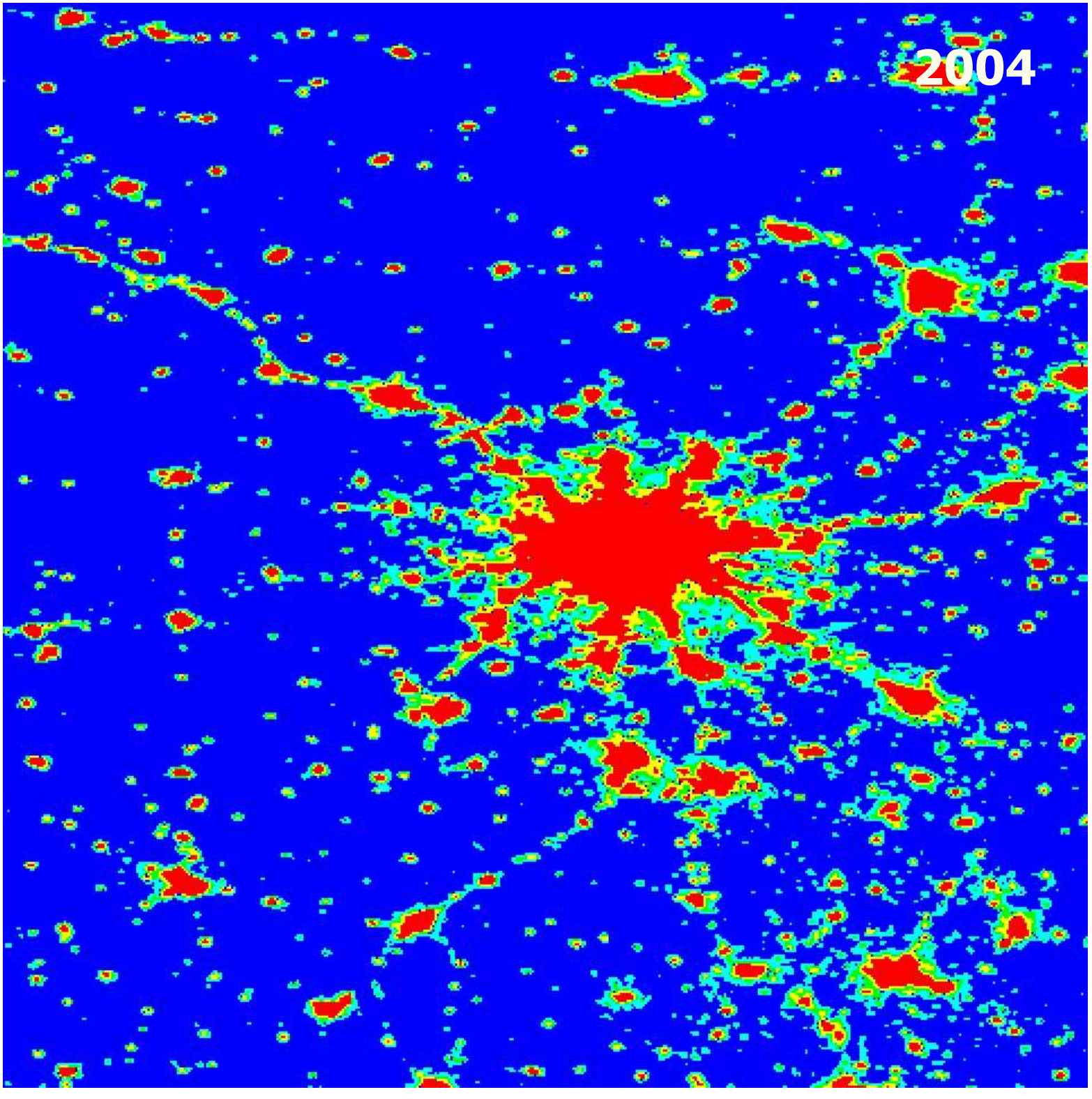
Evolution of Moscow region 1992-2013.

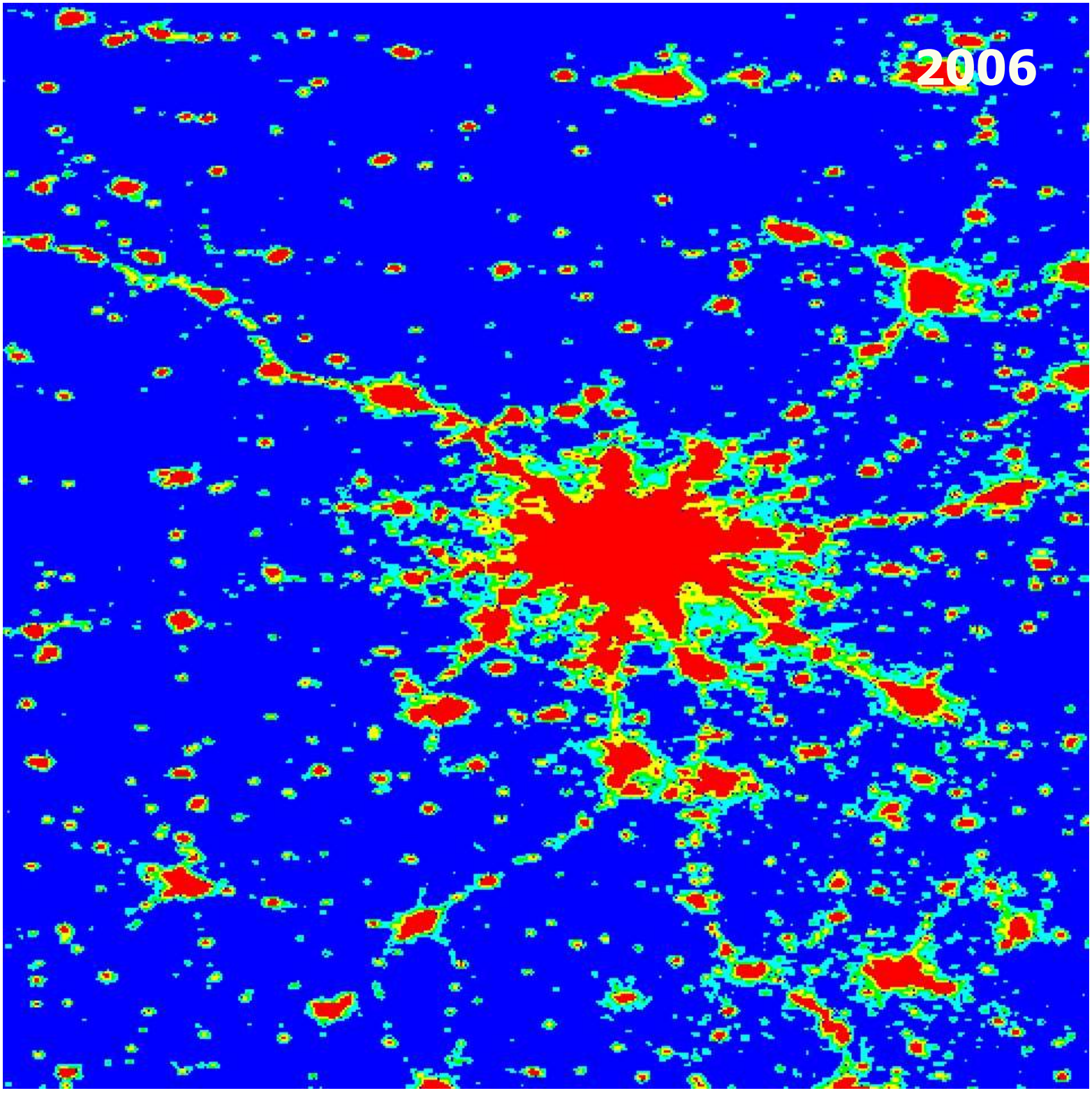
Top row, left to right:
1992г., 1996г., 2000г.
Lower row, left to right:
2004, 2008, 2013.

Colors show "levels of urbanization" (from city center to outskirts):
(1) red -> (2) yellow ->
(3) green -> (4) light blue ->
(5) dark blue


2000

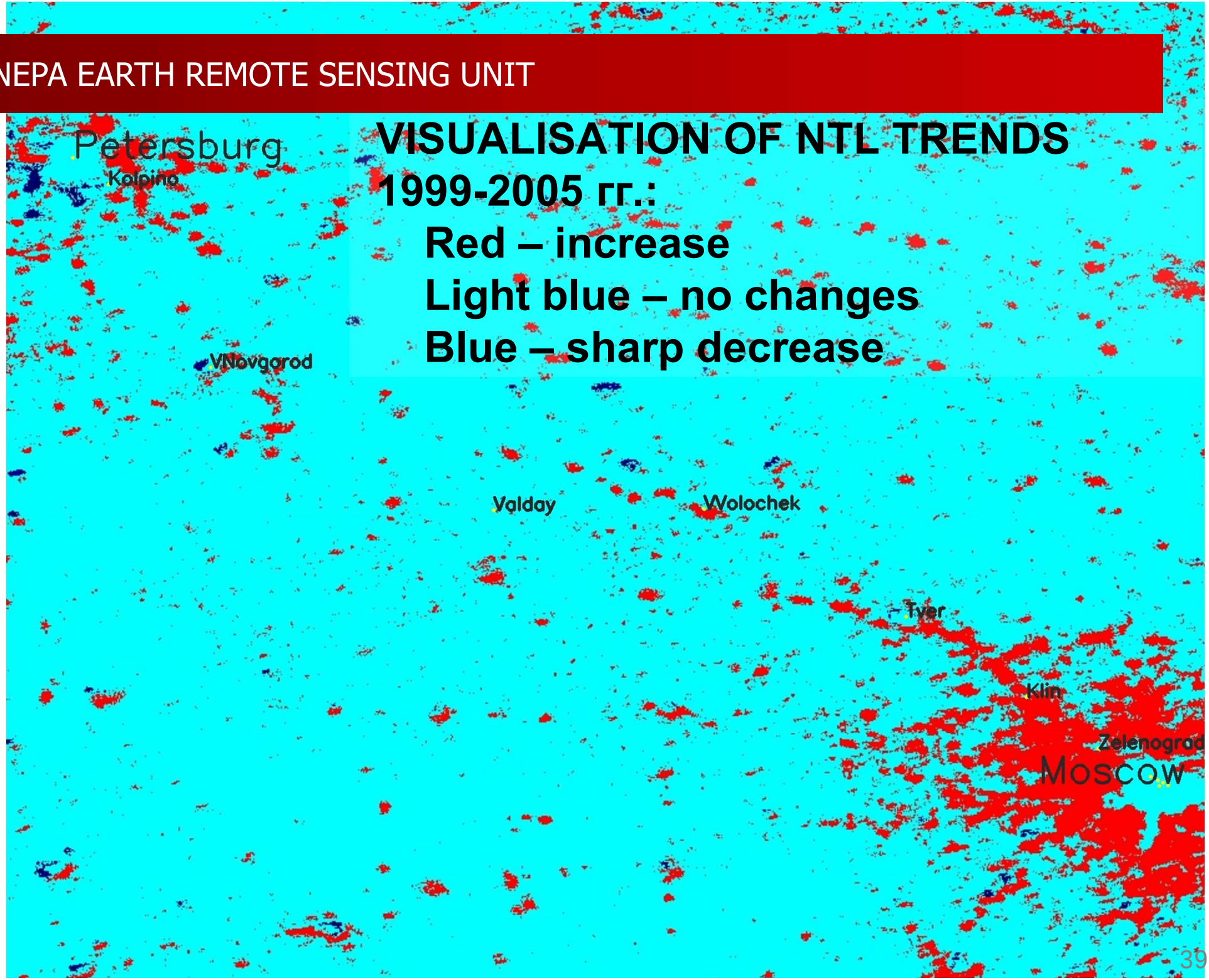

2002


2004


2006

# Next map?

## Predictive models




# VISUALISATION OF NTL TRENDS 1999-2005 гг.:

**Red – increase**

**Light blue – no changes**

**Blue – sharp decrease**

# APPLICATIONS – some examples

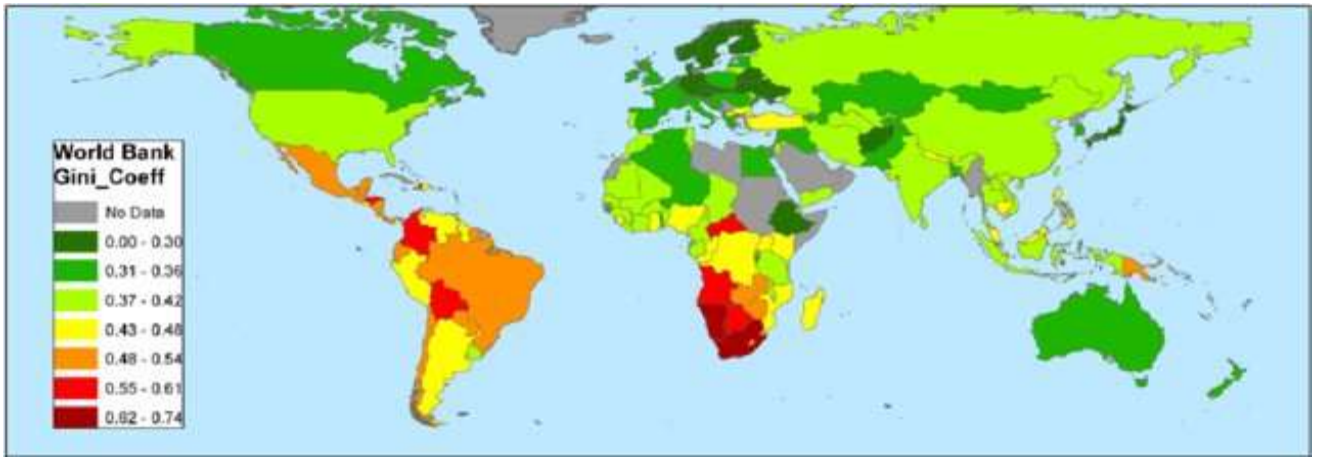
# EMPIRICAL MEASUREMENT OF HUMAN DEVELOPMENT

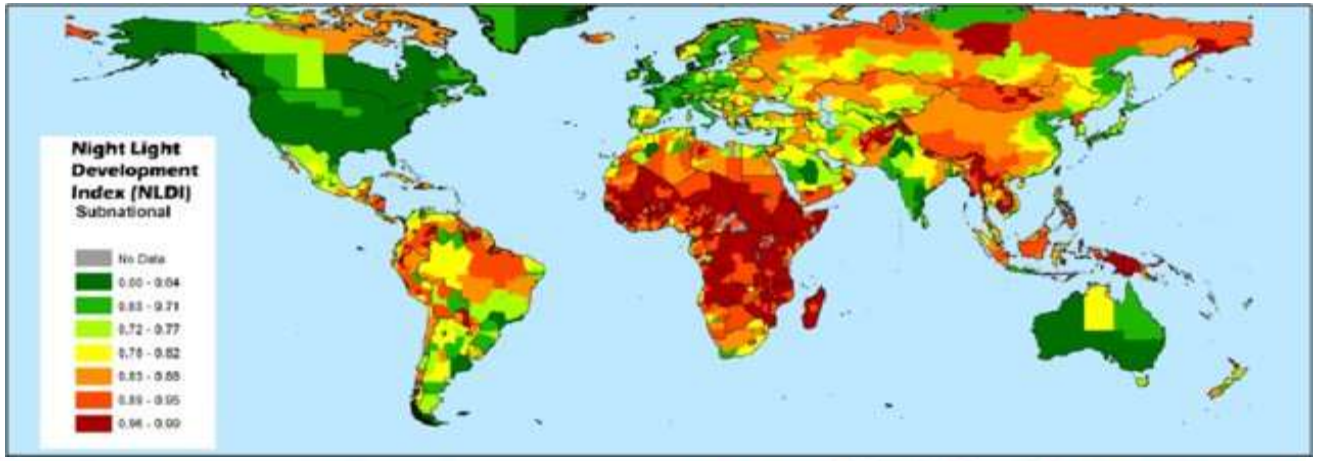
- Night Light Development Index (NLDI) as a simple, objective, spatially explicit and globally available empirical measurement of human development derived solely from nighttime satellite imagery and population density.
- Gini coefficients derived from Lorenz curves are a well-established method of measuring income distribution. Nonetheless, there are many shortcomings of the Gini coefficient as a measure of income or wealth distribution. Gini coefficients are typically calculated using national level data on the distribution of income through the population. Such data are not available for many countries and the results are generally limited to single values representing entire countries. The NLDI measures the co-distribution of nocturnal light and people. It is derived without the use of monetary measures of wealth and is capable of providing a spatial depiction of differences in development within countries.

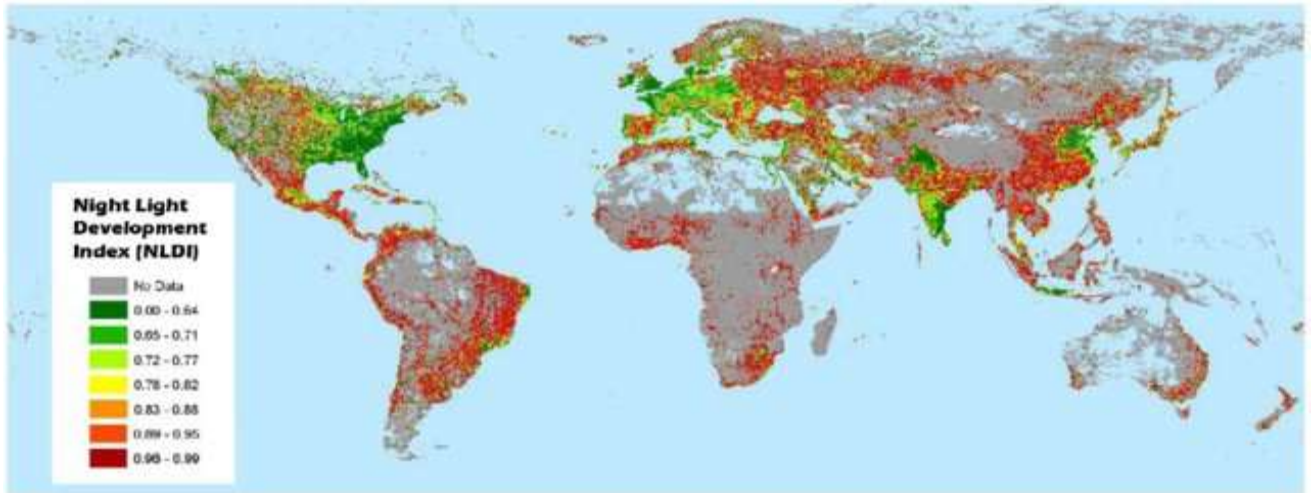
3

# Nighttime Lights Derived Assessment of Regional Inequality

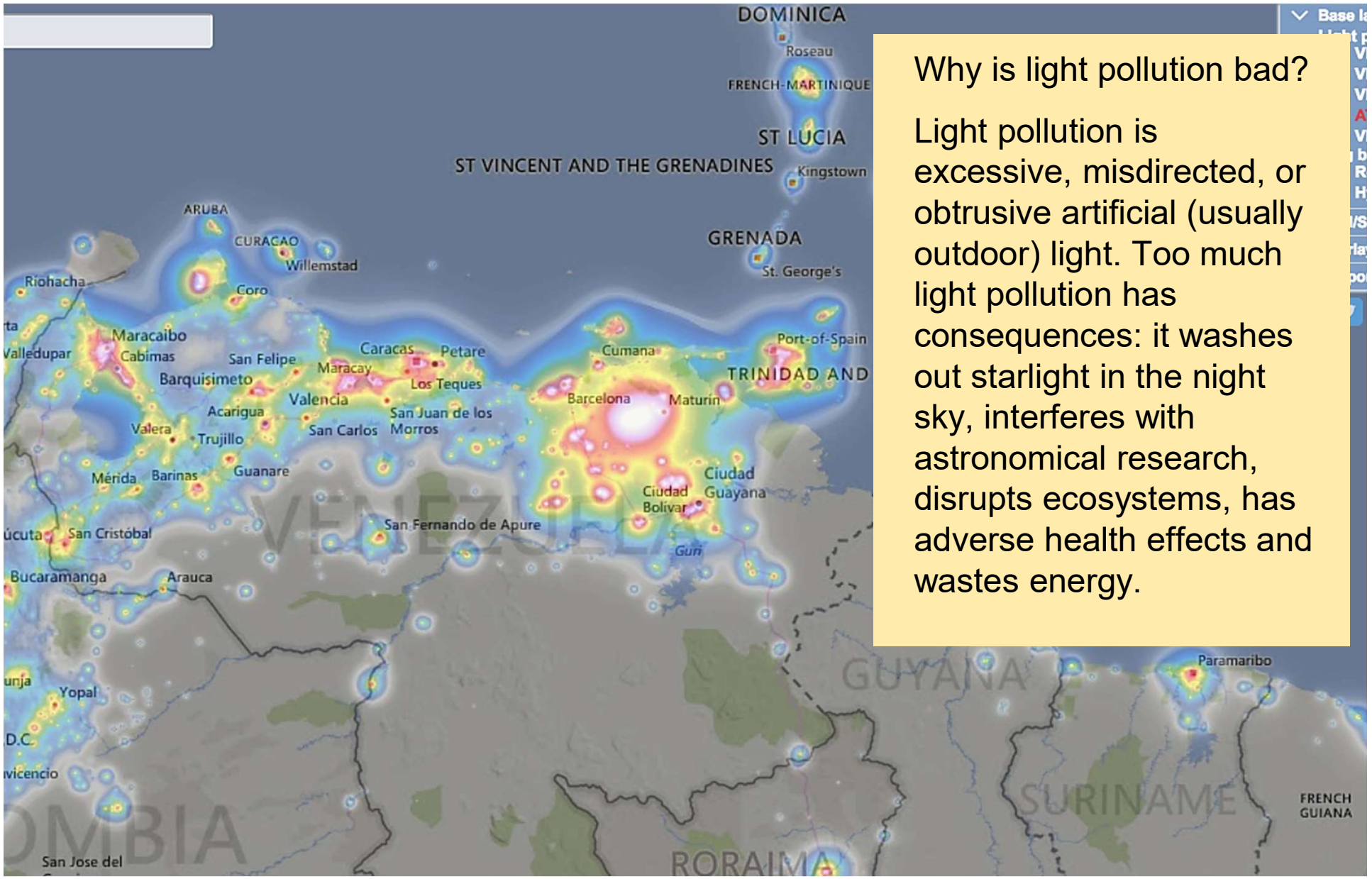
- Gini coefficients 2006. World Bank
- Night Light Development Index (NLDI
  - Subnational level.
  - Fine level 0.25° (approx 27 km)



# Ecology – Light pollution in Venezuela



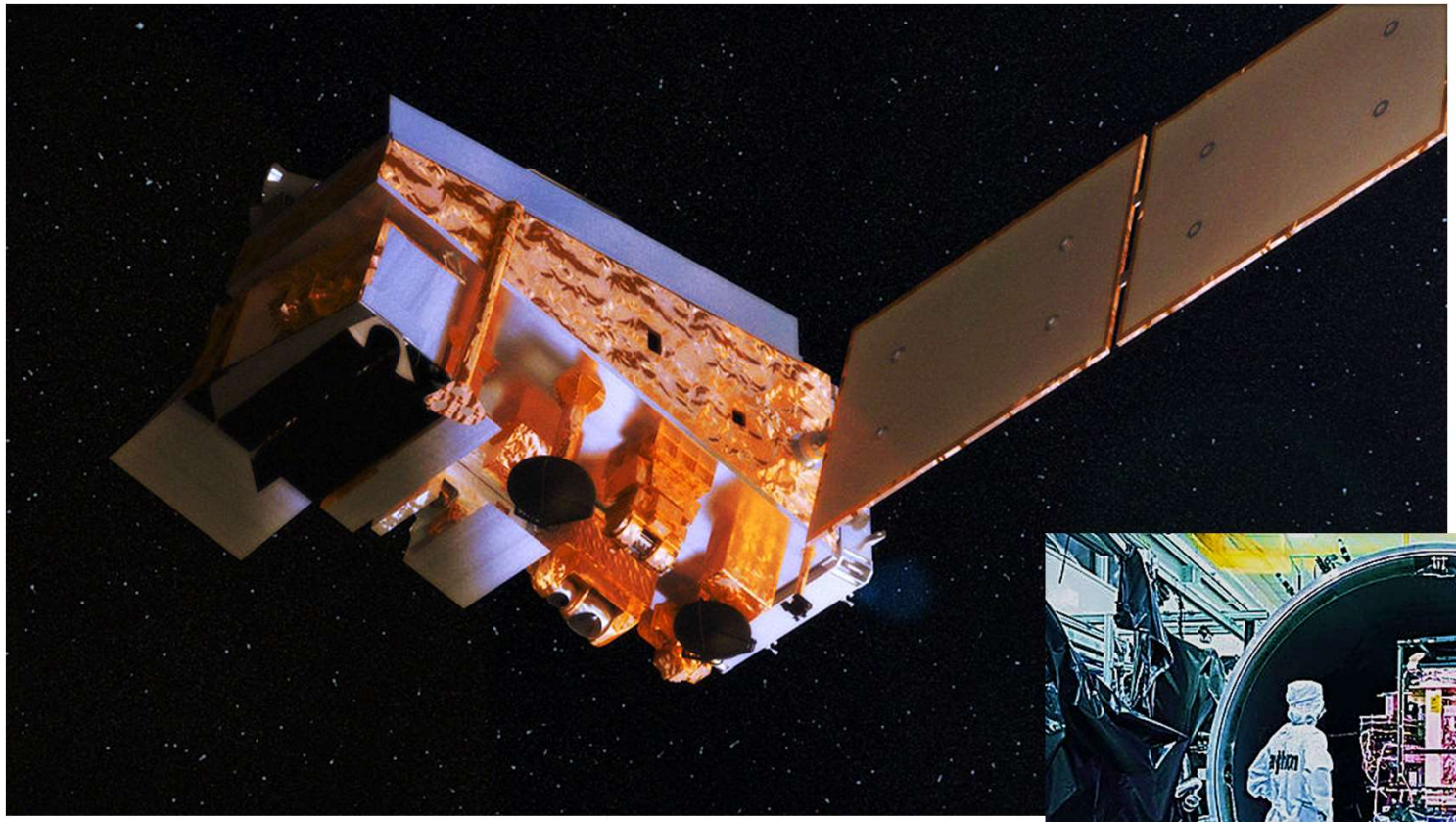

Why is light pollution bad?

Light pollution is excessive, misdirected, or obtrusive artificial (usually outdoor) light. Too much light pollution has consequences: it washes out starlight in the night sky, interferes with astronomical research, disrupts ecosystems, has adverse health effects and wastes energy.

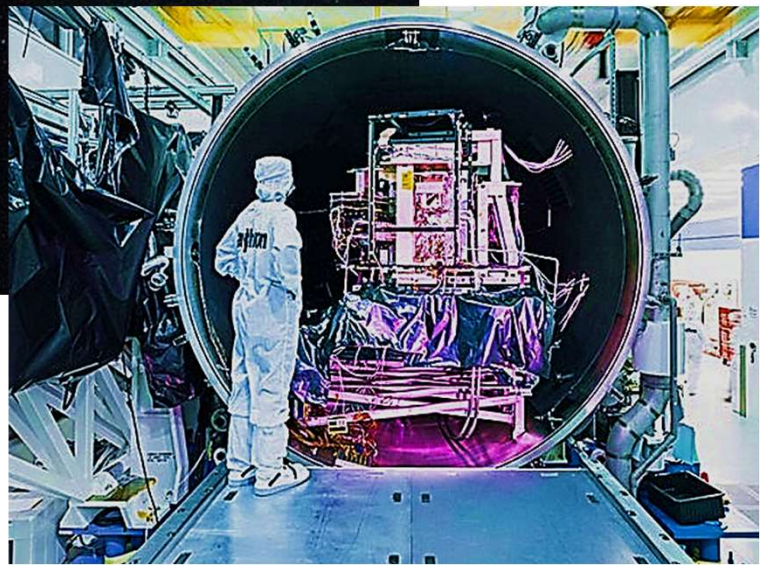
NTL DATA
- Data
- Data processing levels

# Visible Infrared Imaging Radiometer Suite (VIIRS)

The Joint Polar Satellite System (JPSS) is the latest generation of U.S. polar-orbiting, non-geosynchronous, environmental satellites.

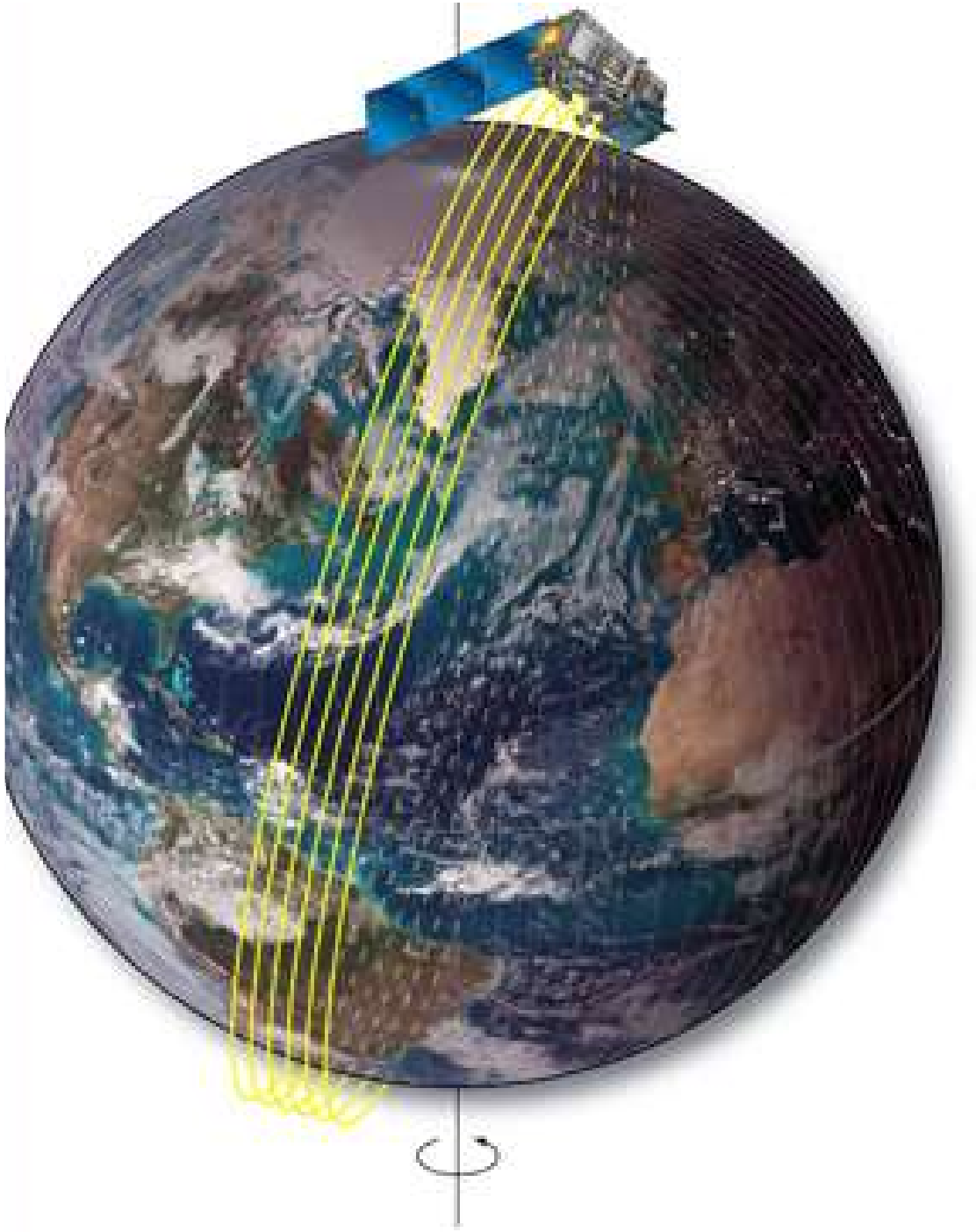


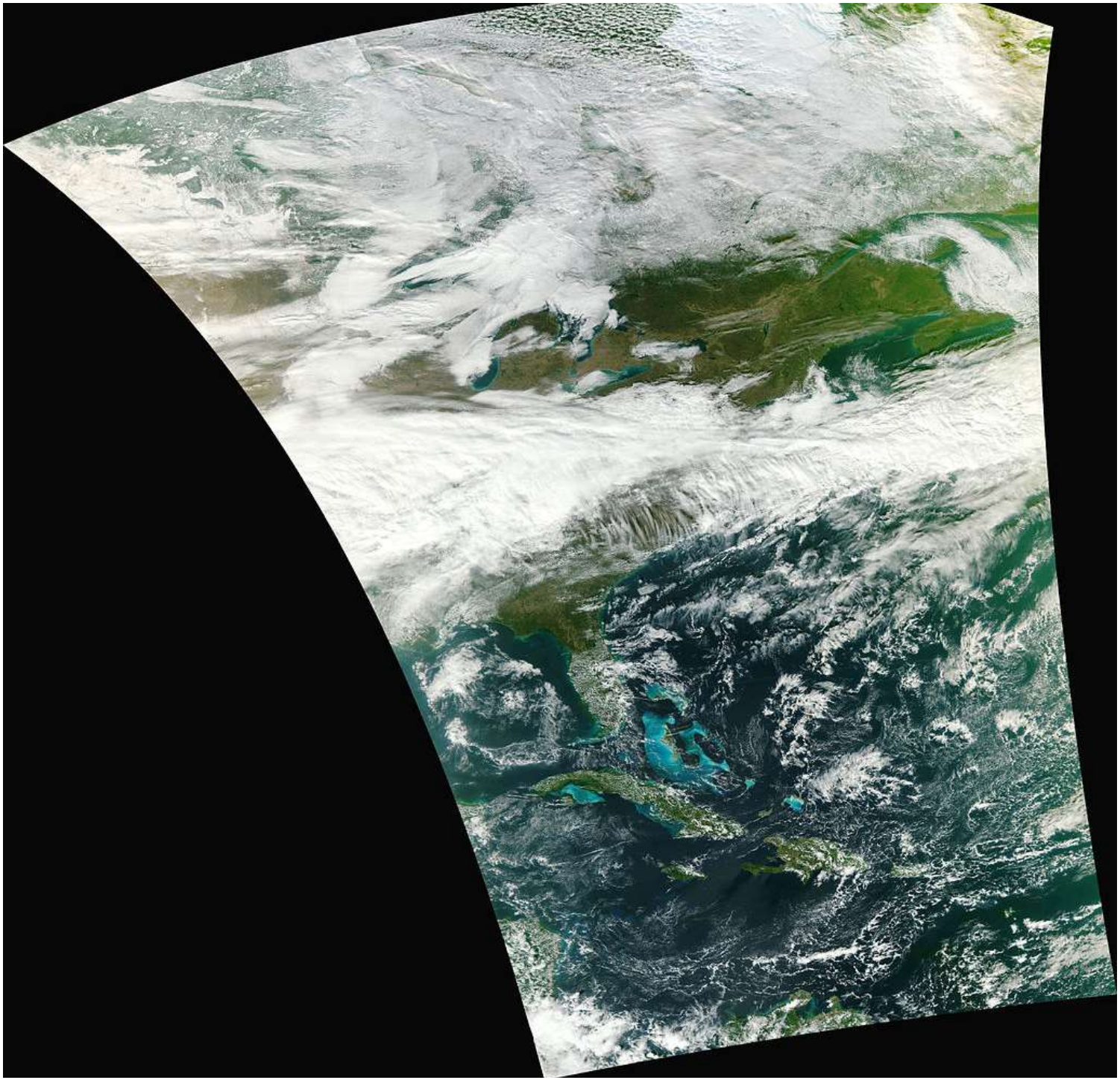
VIIRS



# JPSS, polar orbit

A polar orbit travels north-south over the poles and takes approximately an hour and a half for a full rotation. As the satellite is in orbit, the Earth is rotating beneath it. As a result, a satellite can observe the entire Earth's surface (off-nadir) in the time span of 24 hours.





# Multispectral observations

# Color vision

- RGB

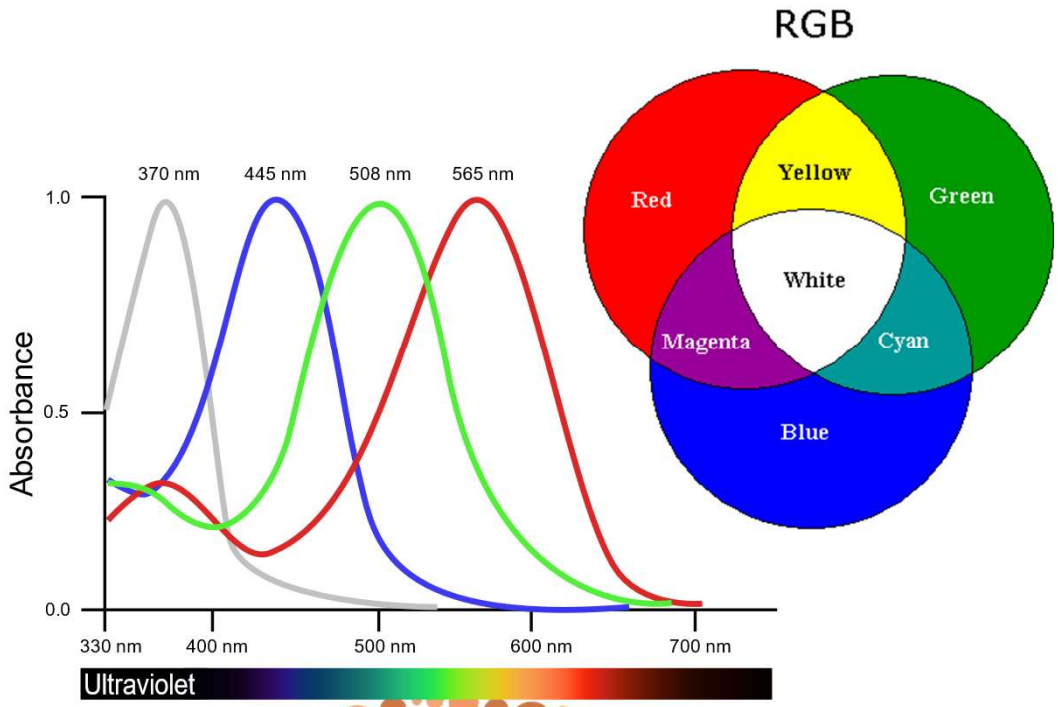
- Primates
  – have trichromatic vision

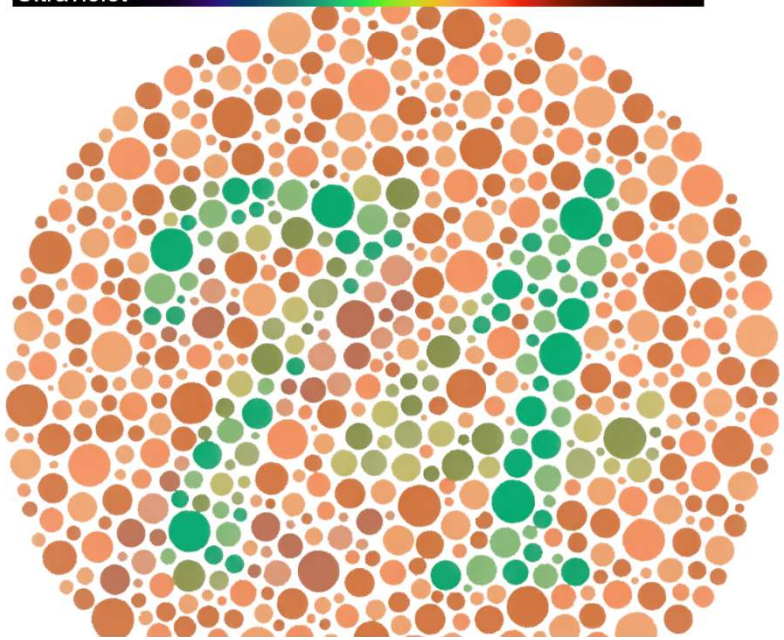
  Most birds and fishes
  – tetrachromatic

  Elefants
  – bichromatic

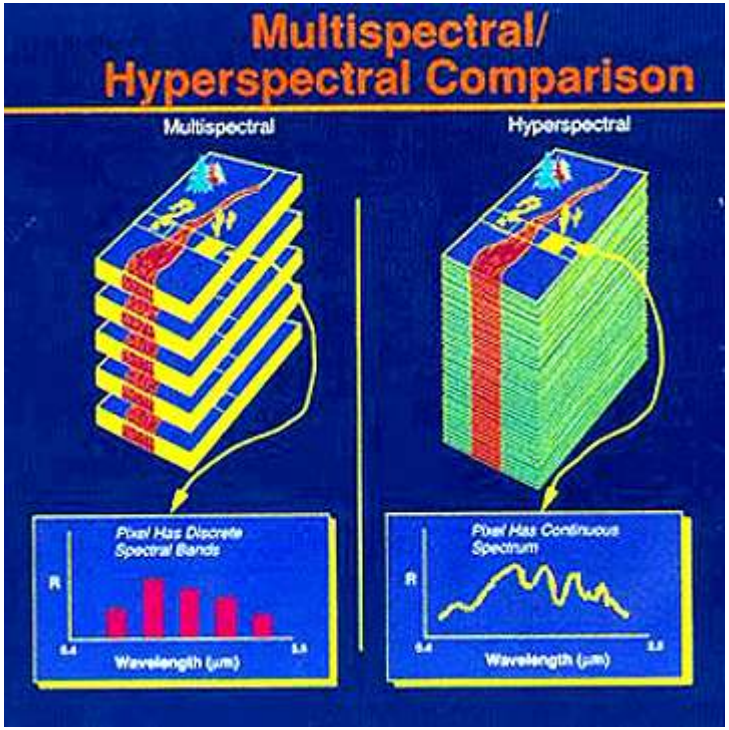
- Advantages of “upgrading”

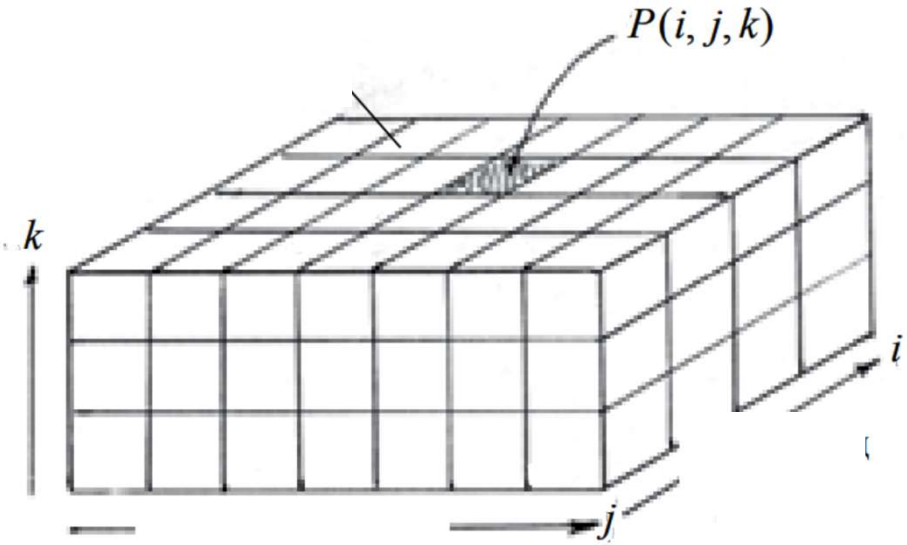
- Disadvantages of “ downgrading“



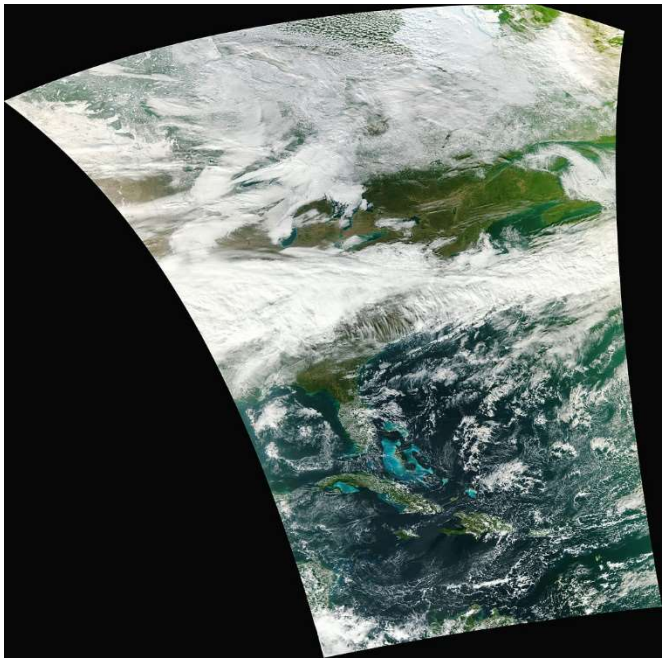



# Multispectral observations

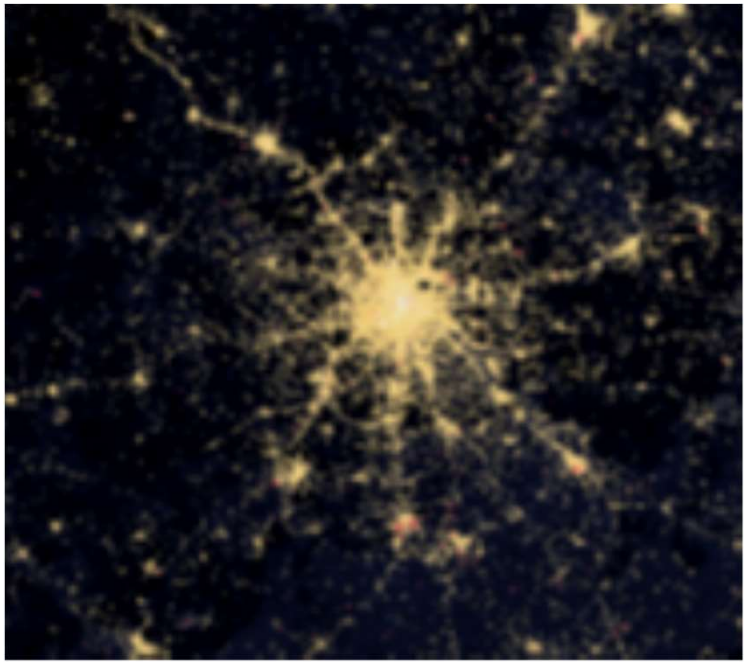


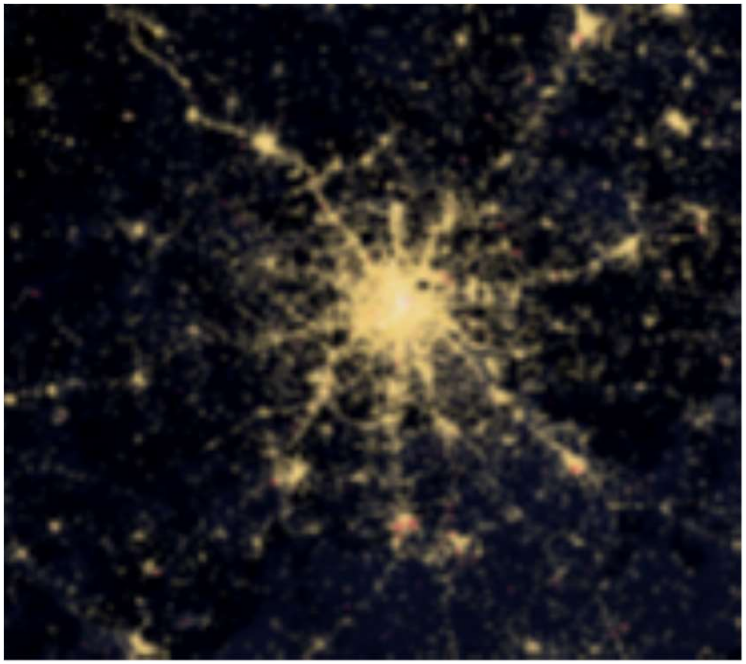



# NTL data processing levels

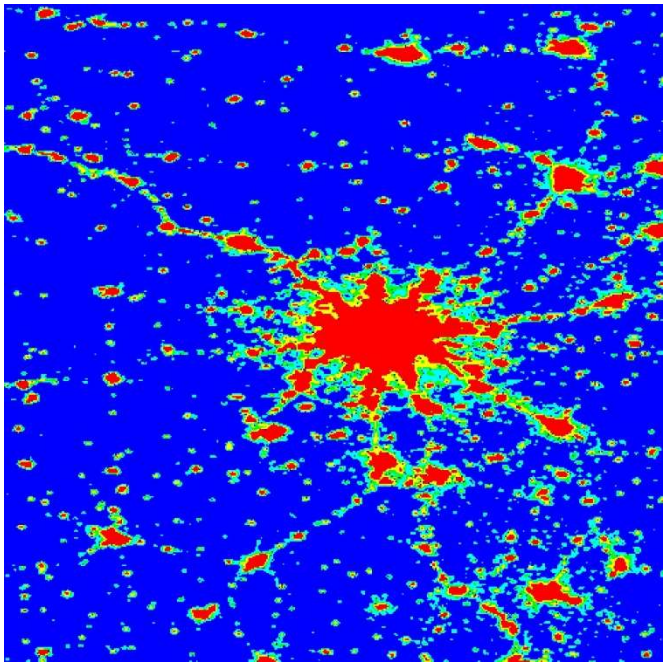


I, II





III



CATEGORIZATION

- Categorization of NTL applications
- NTL vs “other” data and methods

# CATEGORIZATION IS NEEDED

- TO UNDERSTAND
  To understand major categories of NTL applications
  - Areas of applications (economical statistics, urbanization, environmental, …)
  - Multitemporal or cross-sectional
  - …

- TO "DO THE RIGHT THING WITH THE RIGHT KIND OF THING"
  To understand how NTL data and NTL-based applications are different from other approaches. In short
  - The data is captured by instruments in a theory neutral way.
    Information/knowledge is stored in computers.
    Processed by software.
    The results are reproducible.
  - Global coverage, high temporal and special resolution
  - Remote sensing allows obtaining uniform and comparable in quality information simultaneously for large areas, which is practically unattainable with any ground surveys.

CATEGORIZATION

- Categorization of NTL Applications
- NTL vs “other” data and methods

# AREAS OF NTL APPLICATIONS (A.Troussov)

- Correction and decomposition of GDP
- Urbanization and Demography
- Monitoring of greenhouse gas emissions (in particular, monitoring of gas flares)
- Monitoring of illegal fishery
- Monitoring of natural and manmade disasters (including military conflicts)
- Monitoring of light pollution
  - Lighting technologies
  - Observational astronomy
  - Ecosystems hazard
  - Healthcare, comfort and well-being

# THE USE OF SPACE AND TIME IN NTL APPS (A.Troussov)

- SPACE
  - Pixels – high temperature and high luminosity anomalies
  - Areas – the intent and extend of luminosity

- TIME
  - Multitemporal analysis (shows dynamics)

    Also known in demographic studies as a longitudinal analysis,
    that involves repeated observations of the same variables (e.g., people)
    over short or long periods of time
    Also known as a cross-sectional analysis in economics,
    which examines the empirical relationship between economic variables
    at a particular point in time.
    Also known as a diachronic approach (from δια- "through" and χρόνος "time")
    in linguistics, which considers the development and evolution of a language
    through history.
  - Static analysis (shows situation at a specific point of time)

    Also known as a cross-sectional analysis in economics.
    Also known as a synchronic approach in linguistics,
    which aims at describing a language at a specific point of time.

# ADDITIONAL DATA AND TECHNOLOGIES (A.Troussov)

- NTL applications more and more utilize additional data and technologies:
  - Statistics
  - Machine Learning
  - Visualization
  - Geographic Information Systems
- Examples of additional data:
  - Geotagged data from the Internet.
    See, for instance,
    Levin et al. *Utilizing remote sensing and big data to quantify conflict intensity: The Arab Spring as a case study.* 2018.
  - Daytime satellite images

# MORE EXAMPLES OF NTL APPLICATIONS

Examples/Publications:

«CENSUS FROM HEAVEN»
Sutton, Roberts, Elvidge and Baugh (2001)

# Estimation of the global human population

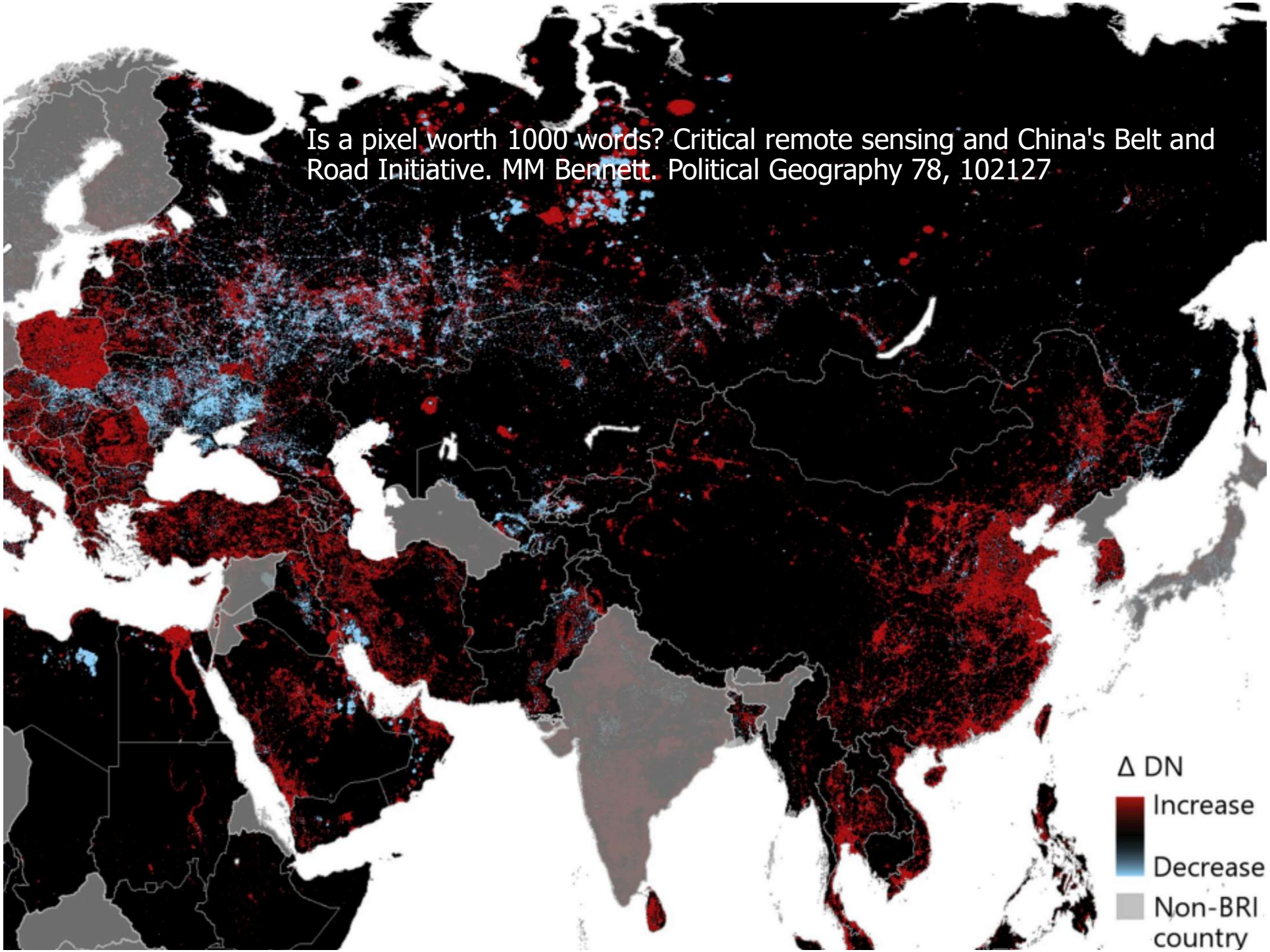
- Census from Heaven: an estimate of the global human population using night-time satellite imagery. Sutton, P. , Roberts, D. , Elvidge, C. and Baugh, K. (2001)
- Models of population derived from NTL data are developed
- An example of the application

| Name of cluster | Area of cluster ($km^2$) | Actual population of cluster | Estimated population of cluster | % Error |
|---|---|---|---|---|
| Tokyo–Yokohama | 5423 | 32332000 | 27049627 | –16 |
| New York–Philadelphia* | 4930 & 7990 | 25608700 | 15274060 | –40 |
| Mexico City | 3065 | 18459901 | 18923719 | 3 |
| Bombay | 1579 | 16748782 | 10650617 | –36 |
| Sao Paulo | 2036 | 15980500 | 11493200 | –28 |
| Los Angeles | 8534 | 15047800 | 10669187 | –29 |
| Manila–Quezon City | 1269 | 14519828 | 14205262 | –2 |
| Calcutta | 1541 | 13880513 | 10308818 | –26 |
| Seoul | 2039 | 12892776 | 13362102 | 4 |
| New Delhi | 2245 | 12819200 | 17061602 | 33 |
| Buenos Aires | 2969 | 12294276 | 12372510 | 1 |
| Chinese cities with estimates greater than 10 million | | | | |
| Beijing | 1951 | 10819000 | 10871719 | 0 |
| Guangzhou (multi-city conurbation) | 4371 | ? | 28276887 | ? |

*The New York–Philadelphia cluster was many city conurbations split into two pieces by the Hudson River which contributed to the underestimation.

Examples/Publications:

Infographics
Novel means of researching China's Belt and Road Initiative (BRI)


Is a pixel worth 1000 words? Critical remote sensing and China's Belt and Road Initiative. MM Bennett. Political Geography 78, 102127
Δ DN
Increase
Decrease
Non-BRI country

## Bennett, Mia M.. “Is a pixel worth 1000 words? Critical remote sensing and China's Belt and Road Initiative.” *Political Geography* 78 (2020)

- As a novel means of researching China's Belt and Road Initiative (BRI), this article advances a critical remote sensing agenda that connects the view from above provided by satellite imagery with the grounded, qualitative methodologies more typical of political geography such as ethnographic fieldwork. Satellite imagery is widely used to produce empirics relating to the BRI, and the Chinese state is showing increasing interest in applying Earth observation data to governance. A more critical approach attentive to the politics of remote sensing, especially in light of China's emergence as a space and satellite power and its embrace of big data, is needed to more precisely reveal what changing pixels represent on the ground and expose the potential issues with data captured from high above the planet
- While official cartographic representations of the BRI are scarce, the Chinese government and academic institutes are increasingly relying on satellite imagery – photographs of the Earth taken from space – to support research relating to the BRI, which may also inform future policy interventions. The state’s reticence to publish official maps compared to its eagerness to employ remote sensing points to a key difference between cartography and remote sensing. Whereas maps are considered malleable representations, satellite imagery is imagined as objective, neutral, and, importantly, rational – a key word in Chinese narratives of development and modernization (Anagnost, 1995; Yeh, 2009)

Examples/Publications:

Touristic activities and night light emissions

# Touristic activities and night light emissions

- Krikigianni, Tsiakos & Chalkias (2019): Estimating the relationship between touristic activities and night light emissions, European Journal of Remote Sensing

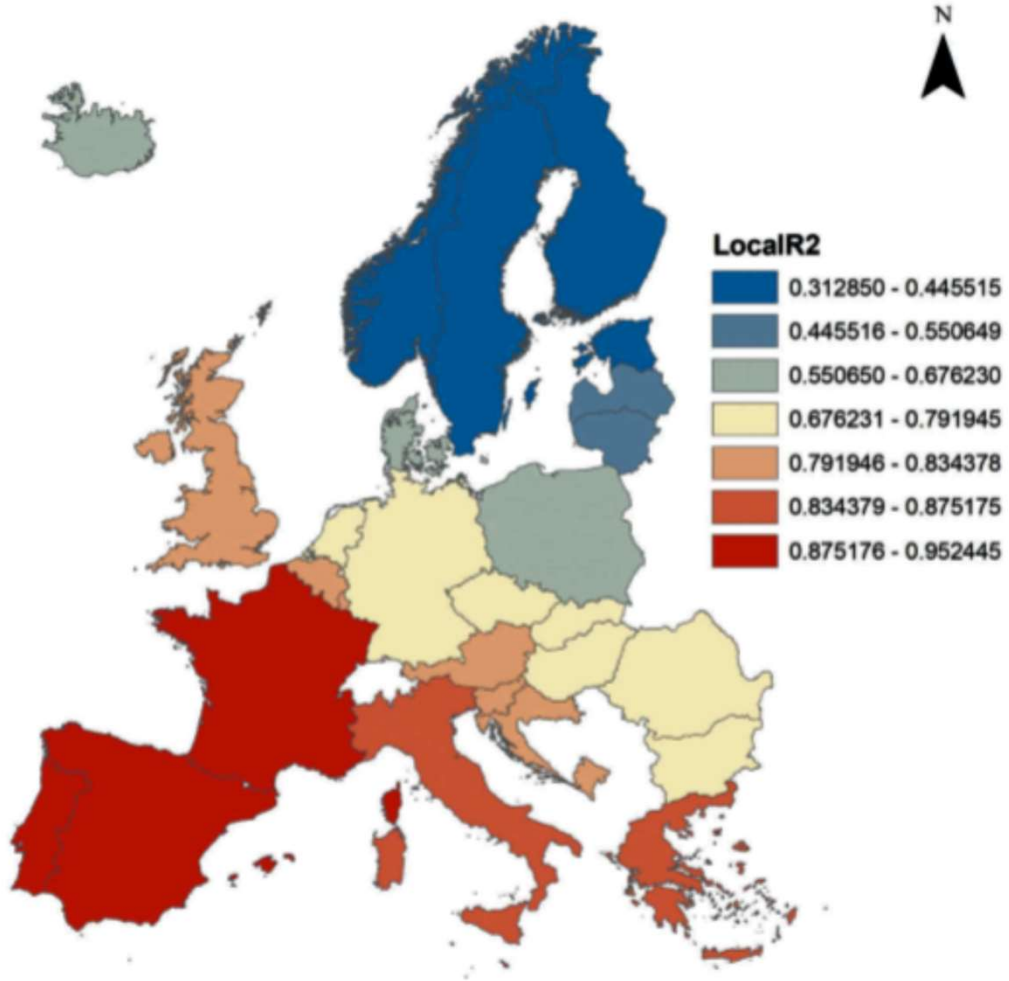



Figure 5. Mapping of local $R^2$ for summer (April–September) period 2013, using VIIRS SOL 2013 predictor variable and total nights spent response variable.

# Examples/Publications:

# Projects of AidData Lab, The College of William and Mary in Virginia

- Examples of the hybrid use of data and technologies:
  NTL,
  Geotagging,
  GIS,
  Visualization

## AidData

- How to estimate return on investment?

OCT 08, 2018

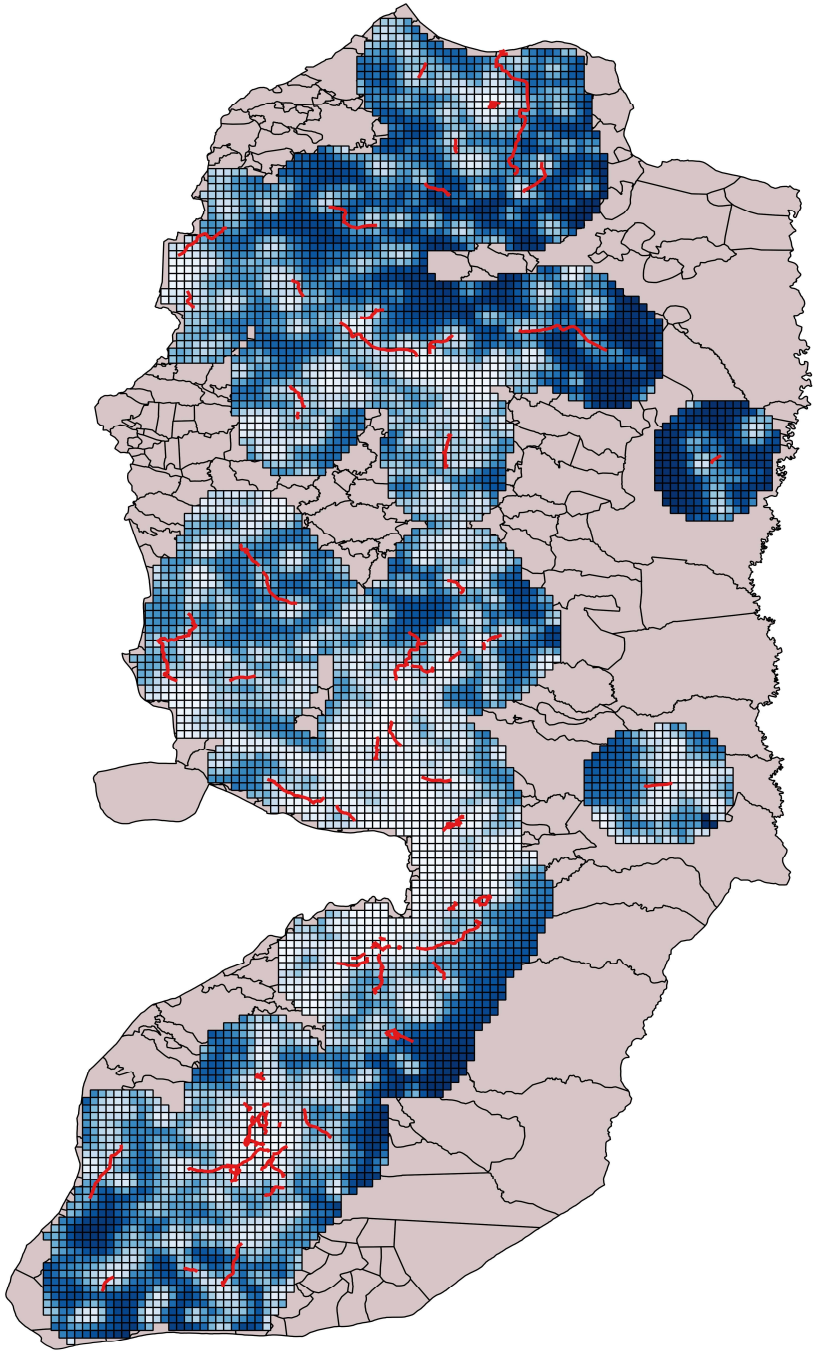
### USAID roads project sparked—and shifted—economic activity in West Bank

AidData merged high-resolution nighttime lights imagery with precisely-located road improvements to discover how a $900-million investment impacted the Palestinian economy.

## AidData

- How to estimate return on investment?

- By analyzing trends in night-time lights
  - "we construct a dataset with monthly outcome measures between April 2012 (11 months prior to the first road improvements) and December 2016 (five months after the last road improvements) for 750m square grid cells within 5km of an improved road segment.
    We compare post-treatment nighttime lights in each cell to counterfactual outcomes obtained from that cell's own preceding nighttime light levels and trends, as well as the outcomes of cells near not-yet-improved road segments."



# Examples/Publications:

# Detection of illegal mining activities

# Detection of illicit sand mining in China

- A large amount of high-quality yellow sand was discovered in the bed of Lake Hongze in 2012, and this finding was soon followed by the appearance of a large number of sand dredging vessels. These sand dredging activities pose a threat to safe drinking water and damage the original ecological environment of the lake and the lakebed, resulting in increased turbidity in the lake and the deaths of fish and shrimp (Yan, 2015)
- Duan H. et al. Detection of illicit sand mining and the associated environmental effects in China's fourth largest freshwater lake using daytime and nighttime satellite images. 2019

## Artisanal and Small-Scale Mining Sites in the Democratic Republic of the Congo Are Not Associated with Nighttime Light Emissions (Christopher Kyba et. al., 2019)

- Maintaining records of artisanal and small-scale mining sites in developing countries requires considerable effort, so it would be beneficial if Earth observation data from space could assist in the identifying and monitoring of such sites. Artificial light emissions are common at industrial-scale mining sites and have been associated with small-scale illegal mining in some contexts. Here, we examine whether known artisanal and small-scale mining sites in the Democratic Republic of the Congo (DRC) are associated with observations of night light emissions by the Visible Infrared Imaging Radiometer Suite Day/Night Band (DNB). Light emissions from the mining sites were not observed: the radiance observed from the sites was near zero and nearly identical to that observed for a set of randomly-chosen locations in the same region. While it is the case that DNB night lights' products provide useful data in other resource extraction contexts, they do not appear to be useful for identifying artisanal mining sites in the DRC.

Examples/Publications:

Google maps will help people plan safer routes, avoiding streets with poor to no lighting

# Planning safer routes

- Google Maps v10.31.0 beta contains strings that indicate that Google is working on a new feature that will help make your night time travels a bit safer. According to the string descriptions, this new Lighting Layer will highlight streets that have good lighting with a yellow color highlight, and by extension, help users avoid streets with poor or no lighting.

  https://www.xda-developers.com/google-maps-prepares-lighting-layer-highlight-brightly-lit-streets-night-travel/

# Examples/Publications:

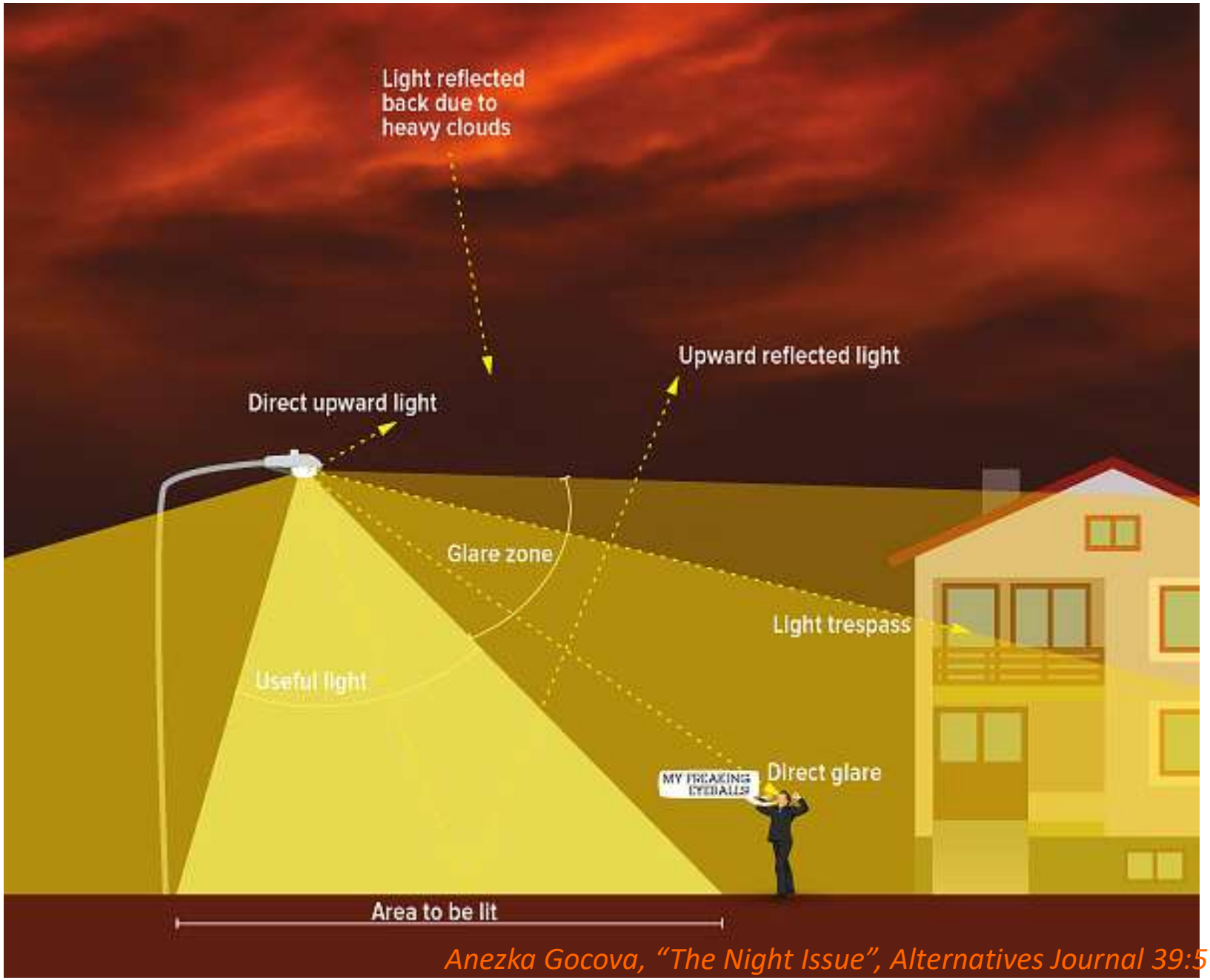
# Light pollution

Light pollution – not only Las Vegas, Kuwait, Singapore, Qatar, Malta, United Arab Emirates, Belgium, Kuwait, Trinidad and Tobago, Netherlands …

Falchi et al. The new world atlas of artificial night sky brightness.
Science Advances, 2016

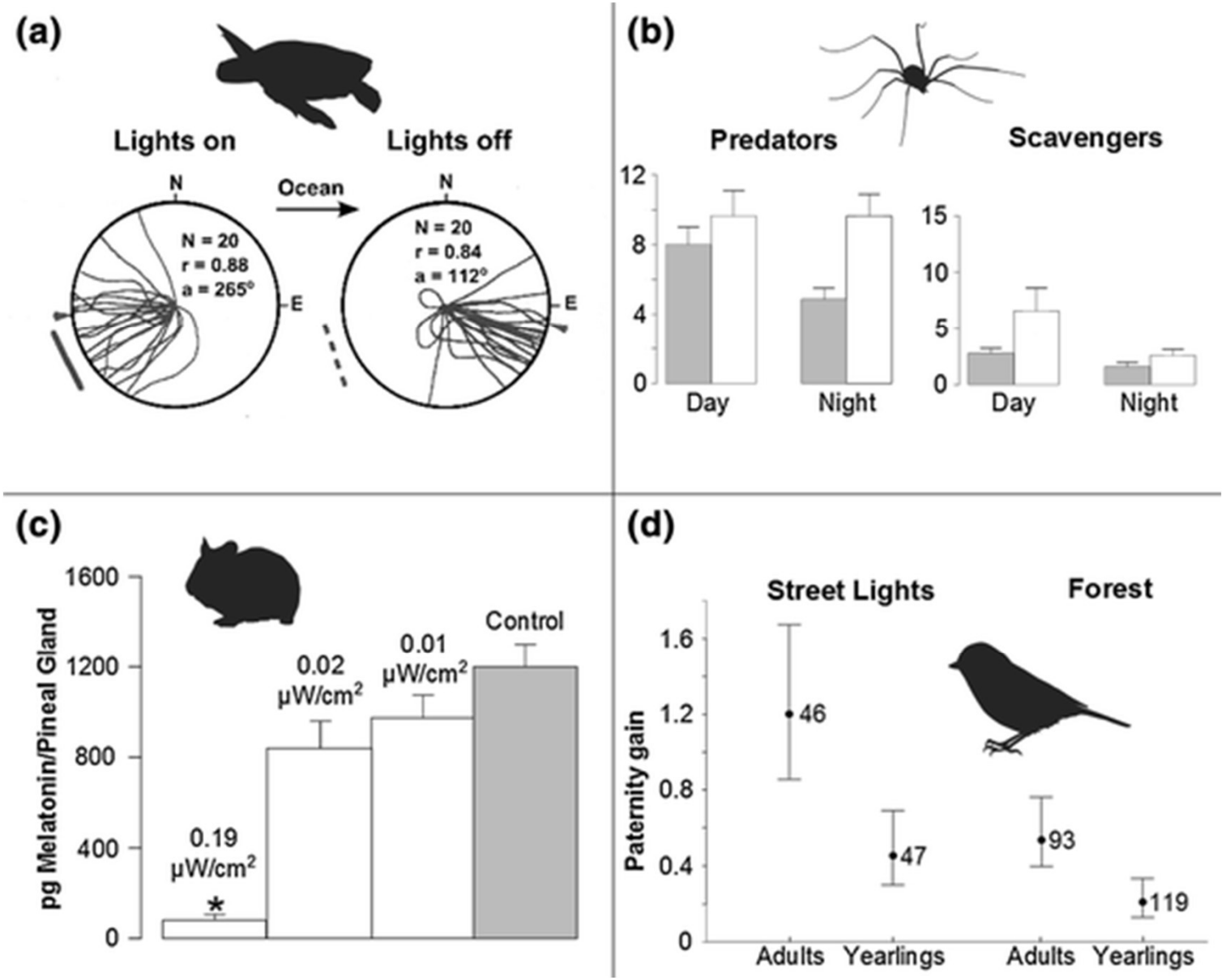

*Anezka Gocova*

# Components of light pollution




*Anezka Gocova, "The Night Issue", Alternatives Journal 39:5 (2013)*

# Alteration of natural light cycles has ecological consequences




https://link.springer.com/article/10.1007/s00442-014-3088-2

# LIGHT POLLUTION

- Remote sensing of night lights differs from other sources of remote sensing in its ability to directly observe human activity from space as well as in informing us on a new type of anthropogenic threat, that of light pollution.
- International Dark-Sky Association non-profit organization

Arches National Park (Utah) Certified as an International Dark Sky July 5, 2019

- MOAB, UT— The National Park Service and the International Dark-Sky Association are pleased to announce Arches National Park as an International Dark Sky Park, a place recognized for its quality night skies and a commitment to protecting and sharing natural darkness.

# LIGHT POLLUTION DISRUPTS AQUATIC INSECTS (UP TO 5 KM)

insects such as mayflies, caddisflies and stoneflies spend the majority of their lives as larvae in streams, eventually emerging as terrestrial adults who may only live for a few days or weeks. The main way these larval aquatic insects move through their habitat is by "drifting" — detaching themselves from the stream substrate and floating with the current before swimming back down to a new patch of substrate. Here's where light comes into play. Drifting puts aquatic insects at risk of being eaten by visually oriented predators  Light pollution disrupts aquatic insects…

## MEXICO'S ENVIRONMENTAL LAW


**Mexico's Environmental Law Will Now Include Regulation of Light Pollution on DECEMBER 17, 2019**

The Senate of Mexico unanimously endorsed legislation that classifies light pollution as a form of environmental pollution this November. The new law makes light pollution subject to regulation under existing environmental laws in the country of Mexico.

# ‘NIGHT MAYORS’ FOR TOWNS AND CITIES

- **The Irish Times Apr 26, 2019**
  **‘Night mayors’ for towns and cities proposed in FG manifesto**
  ***Extended licensing hours for serving alcohol also considered as part of local election plan***

- New “night mayors” will be established in towns and cities to offer cultural “alternatives and additions” to pubs and clubs, under proposals contained in the Fine Gael local election manifesto.

  The move would include consideration of extended licensing hours for serving alcohol, Government figures said. The plan is included in a draft copy of the Fine Gael manifesto for the local elections, which take place on May 24th.

  Other major European cities such as Paris, Berlin, Amsterdam and Zurich have “night mayors”, official appointees tasked with, among other issues, liaising between venue owners and the authorities. The night mayor in Amsterdam, for example, acts as an intermediary between the mayor, city council, business community and residents.

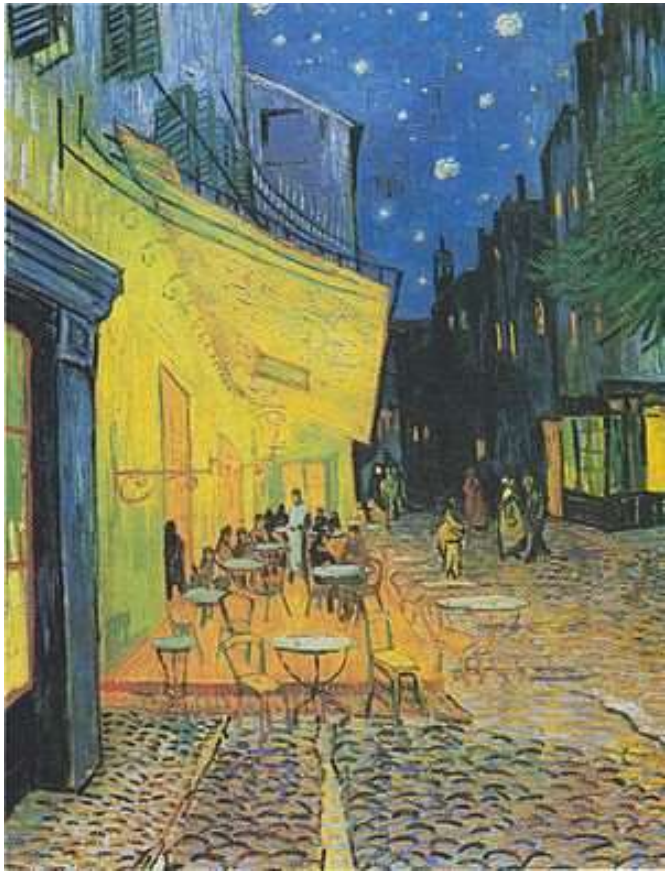
  Industry groups here, such as Give Us the Night, have lobbied for such a position to be created in Dublin and have raised concerns about the closure of a number of high-profile, late-night music venues and nightclubs, such as the Tivoli. Such groups have also raised concerns about the tightening of the licensing laws over the past decade.

# NIGHTLIFE AND THE NIGHT-TIME ECONOMY

- "A vibrant and diverse nightlife is an important part of the cultural offering of any urban area. It makes our towns and cities more attractive and interesting places to live and helps attract domestic and international tourists."

  The Irish Times, Apr 26, 2019.

- NTL are used to map and monitor night-time economy. For instance: Liu, Deng, Wang, Huang, & Ren (2020). Urban nighttime leisure space mapping with nighttime light images and POI data. *Remote Sensing.*



Café Terrace at Night. Vincent van Gogh.

Examples/Publications:

Falchi et al. Light pollution in USA and Europe: The good, the bad and the ugly. 2019

## Data

- For the analysis we use data on artificial night sky brightness from the New World Atlas of Artificial Night Sky Brightness (Falchi et al., 2016a), data on the flux emitted by light sources obtained from the VIIRS satellite images, the population densities and per capita income data for the above regional subdivisions, obtained from the Eurostat and the US Census Bureau.

## Highlights

- New maps of USA and Europe show light pollution from different perspectives.
- Night light flux per capita varies greatly between administrative units in USA and in Europe.
- Night light flux per dollar varies greatly between administrative units in USA and in Europe.
- Germany results to be the best overall in light pollution global ranking.
- USA on average pollutes three times more than Europe in night light flux per capita.

5

RANEPA
THE RUSSIAN PRESIDENTIAL ACADEMY
OF NATIONAL ECONOMY
AND PUBLIC ADMINISTRATION

# Thank you!