Dark side of the light

Human and environmental impact of light pollution

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The Problem

Artificial Light at Night (ALAN) = light emitted at :

causes the **Light Pollution** (LP)

the wrong time and place (when/where not needed)
in the wrong direction
with the wrong intensity
at the wrong color temperature (>3000K)

Estimate the scale of the problem

ALAN

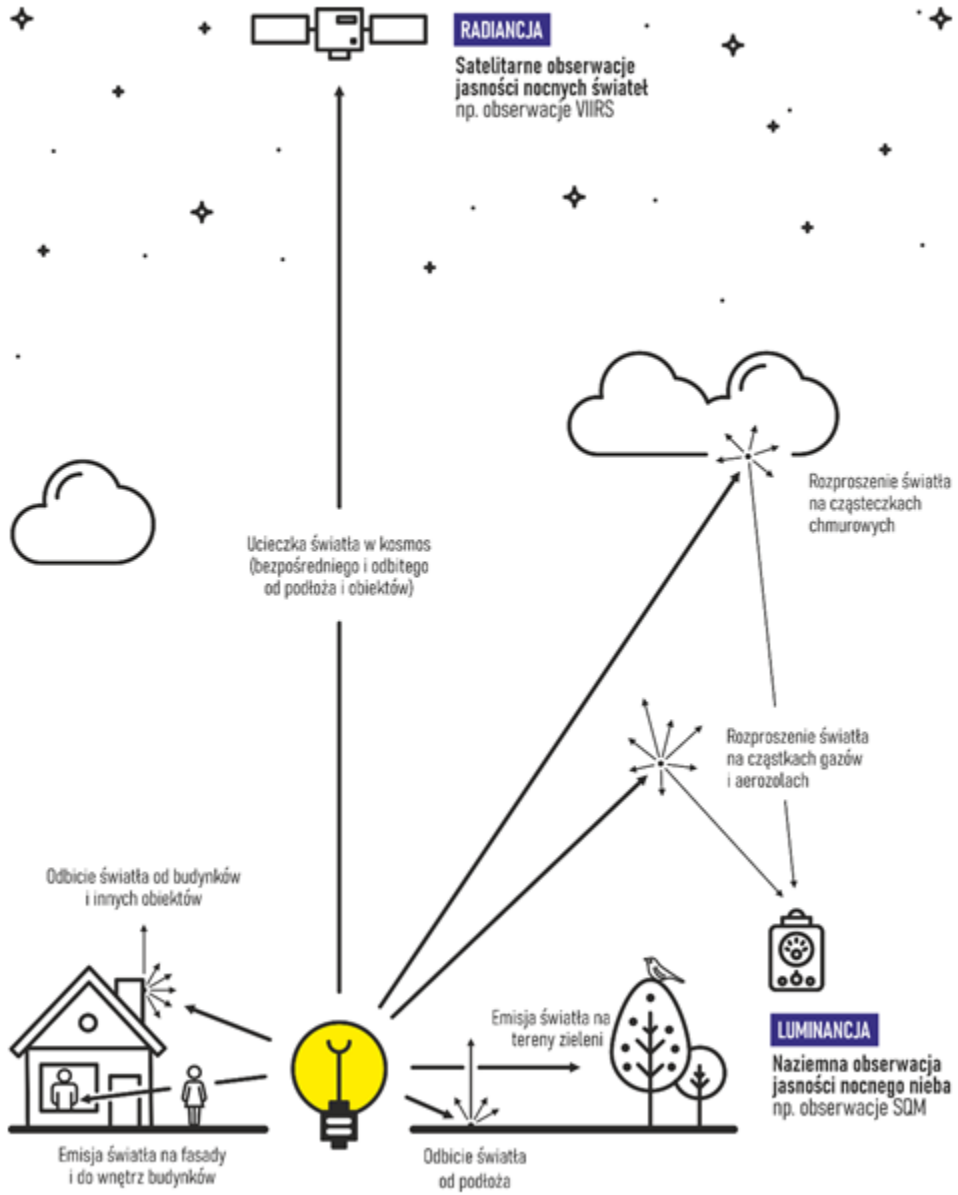
- impact on plants, animals, humans
- recognized as environmental threat
- calls for legislation to stop degradation

Measurements and **monitoring**

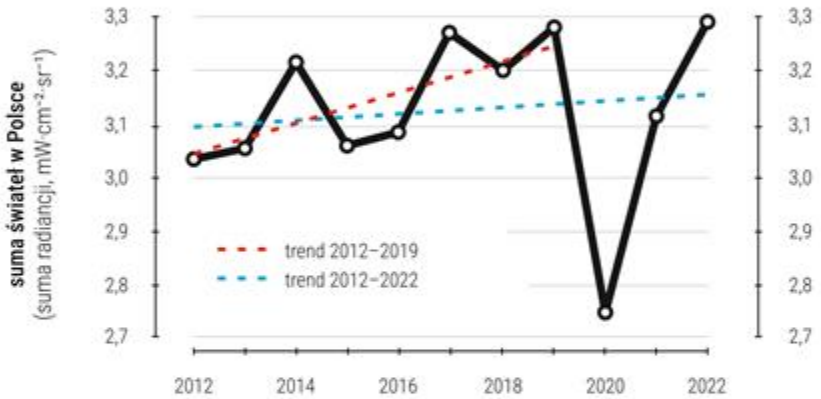
- for scientific studies of the impact
- for assessing the effectiveness of policies

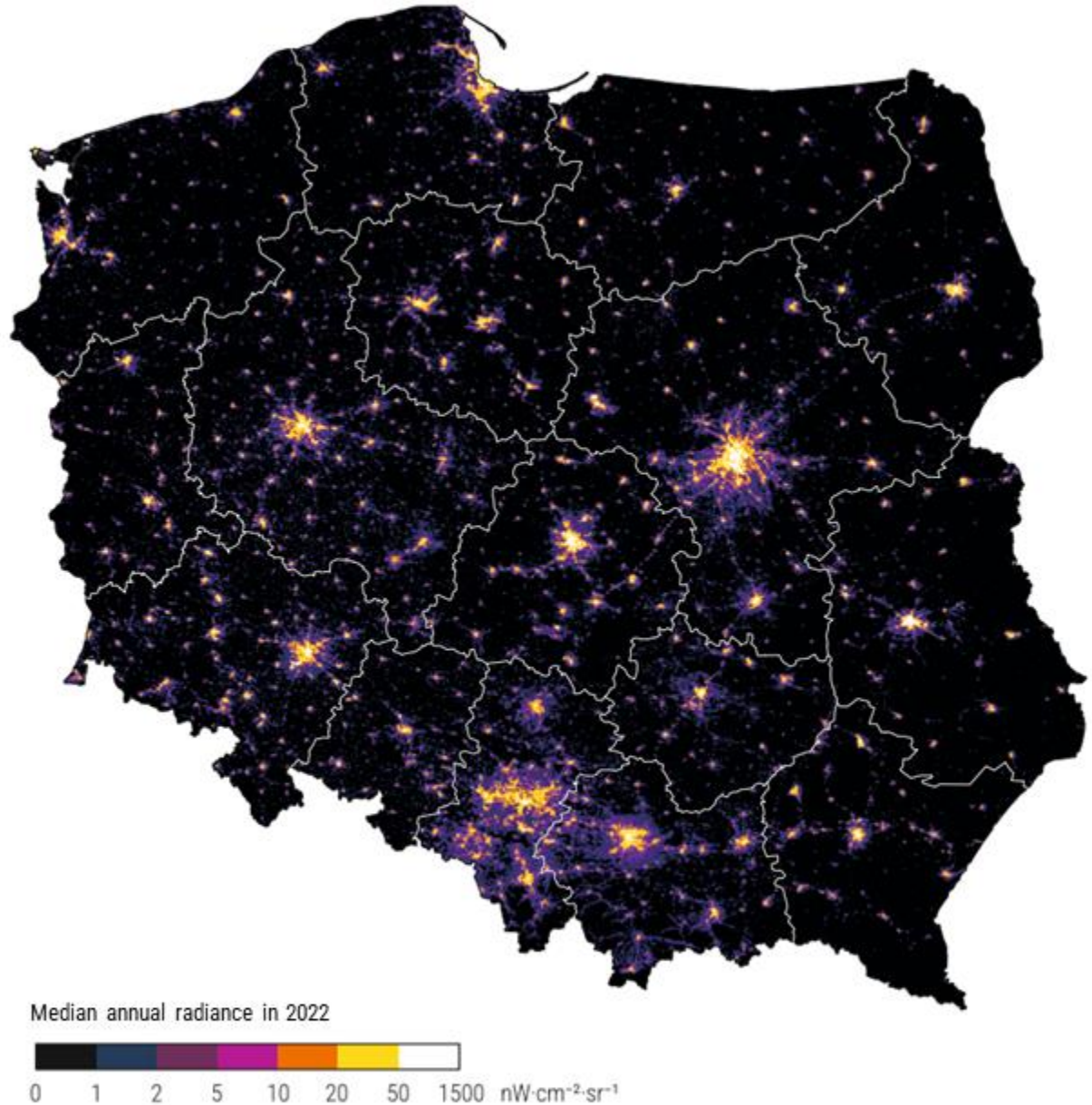
Observations (surface, satellite) + **models**

- exciting moment of birth



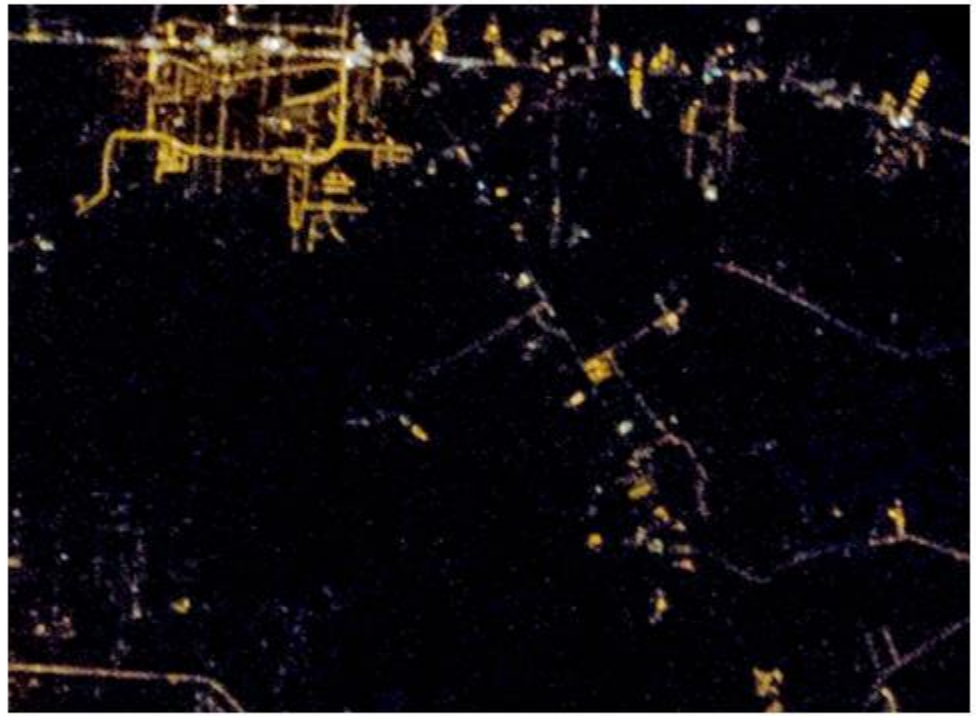
What is a satellite telling us?





- Poland in 2022 was **6.0% brighter** than in the decade 2012-2021
- 8.5% brighter than in 2012 (first year)
- 19.9% brighter than in 2012 (COVID year)

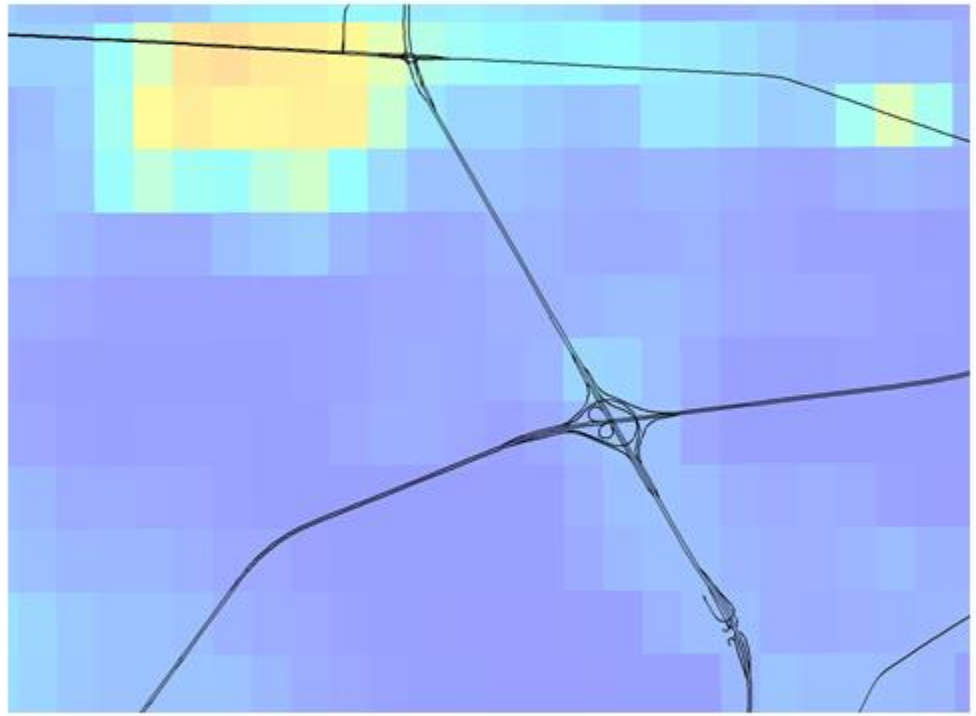
What is a satellite telling us?



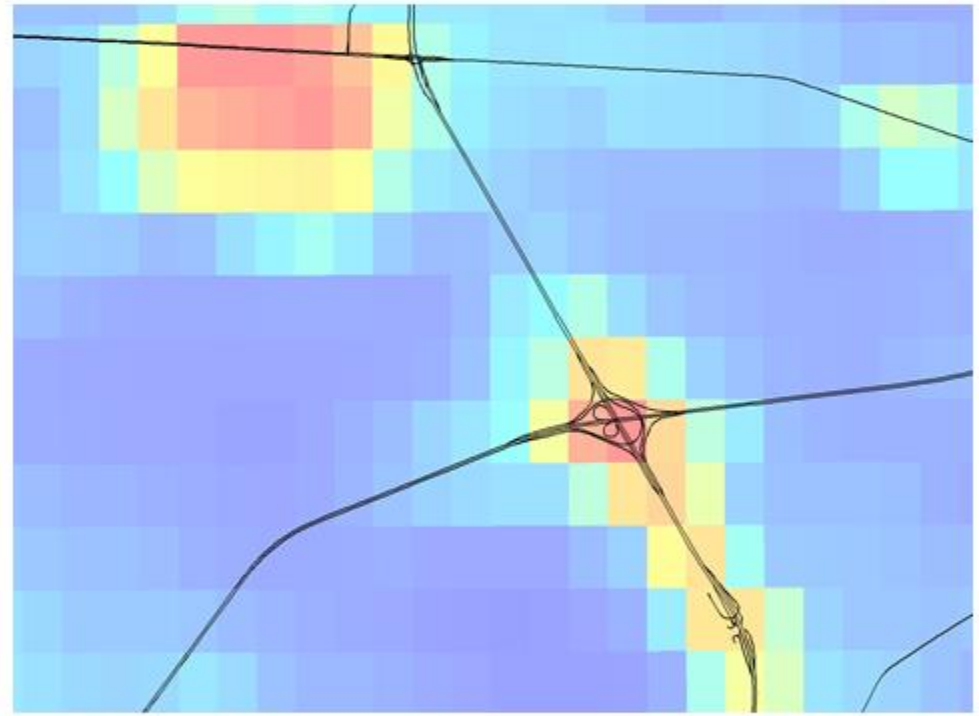
2015-10-08 (RGB photo, International Space Station)

2022-09-06 (RGB photo, International Space Station)

What is a satellite telling us?

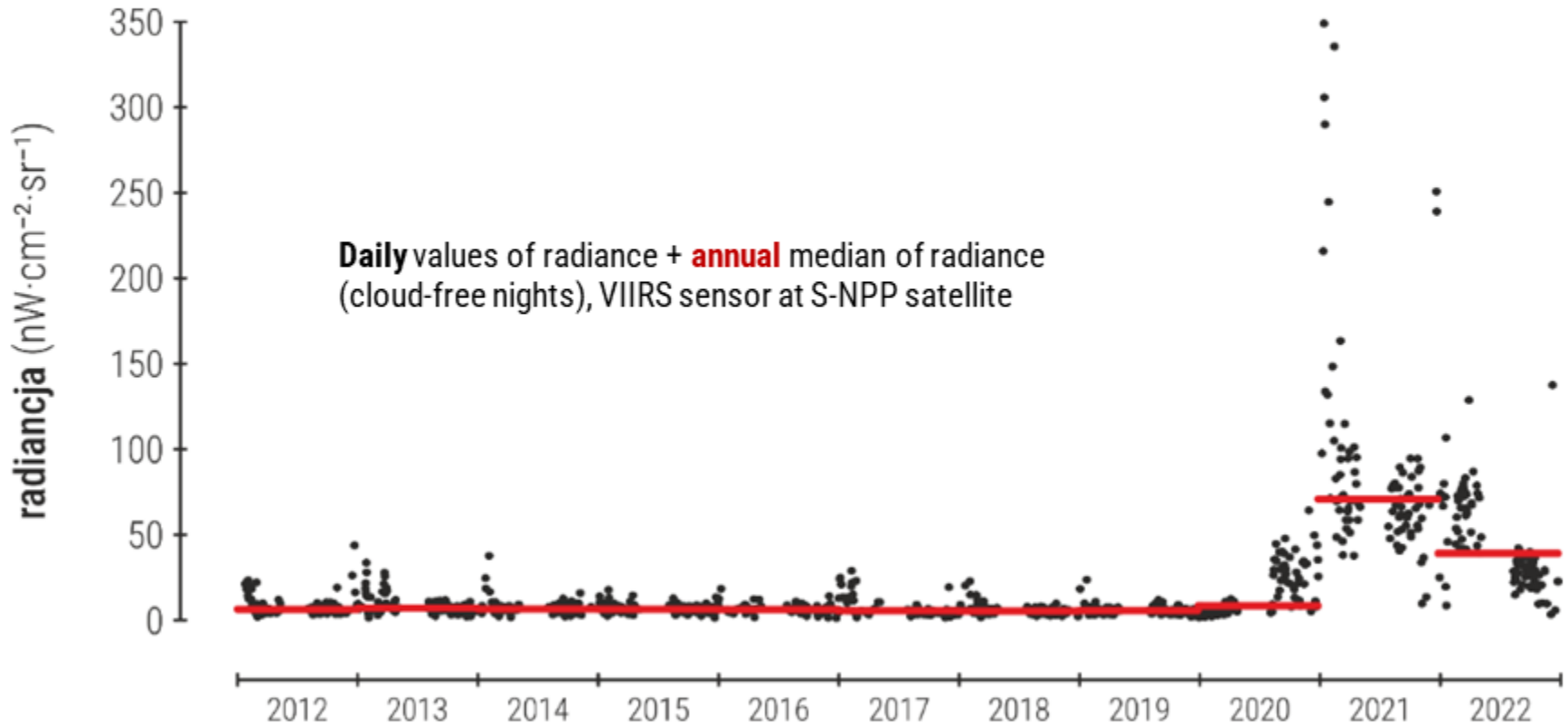


2012 (median annual radiance, VIIRS sensor at S-NPP satellite)



2022 (median annual radiance, VIIRS sensor at S-NPP satellite)

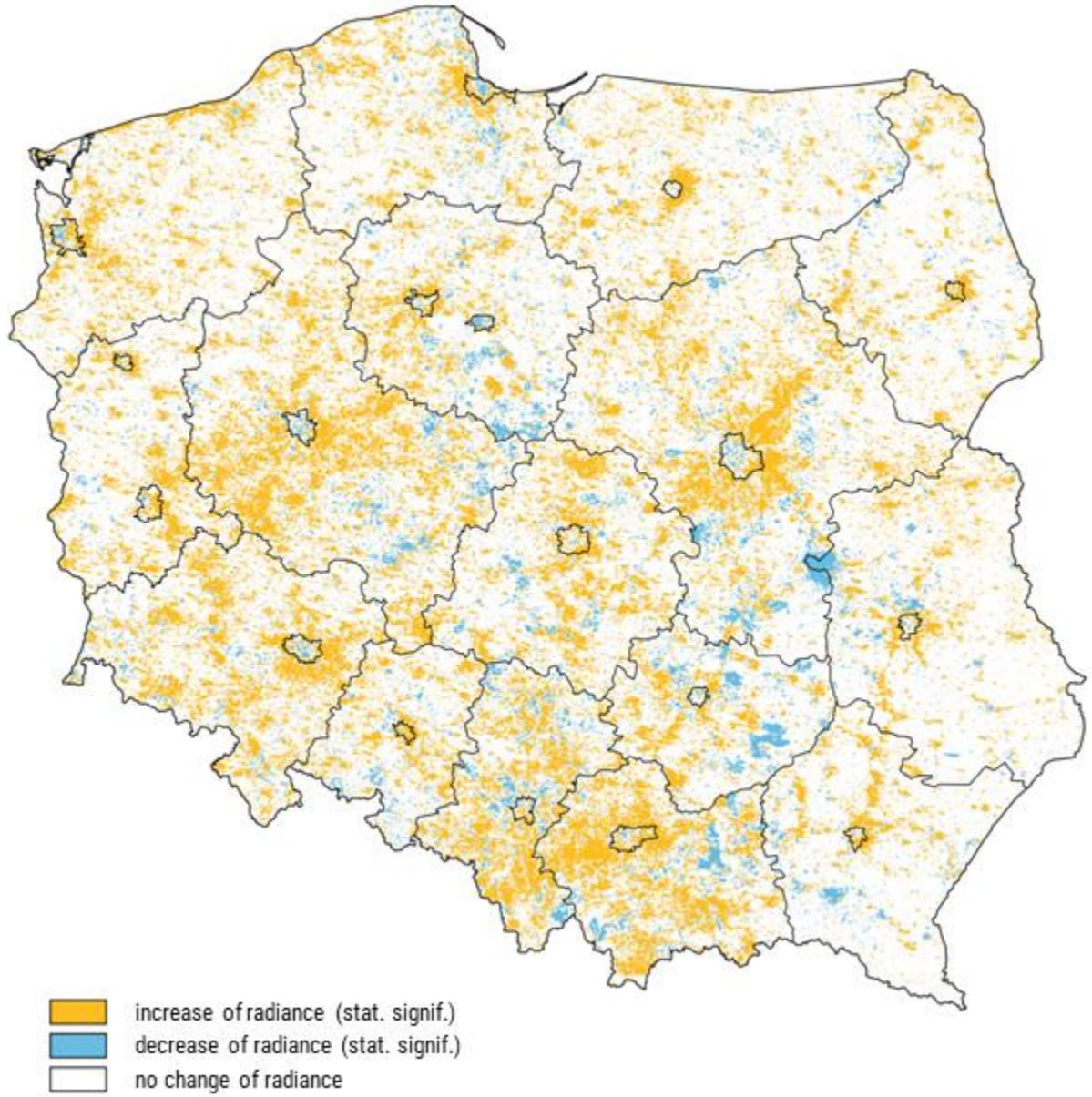
What is a satellite telling us?



What is a satellite telling us?

- **23.3%** of Poland – increase in radiance
- **5.2%** of Poland – decrease in radiance
- **71.5%** of Poland – no significant change

Data: 2022 vs 2012-2021



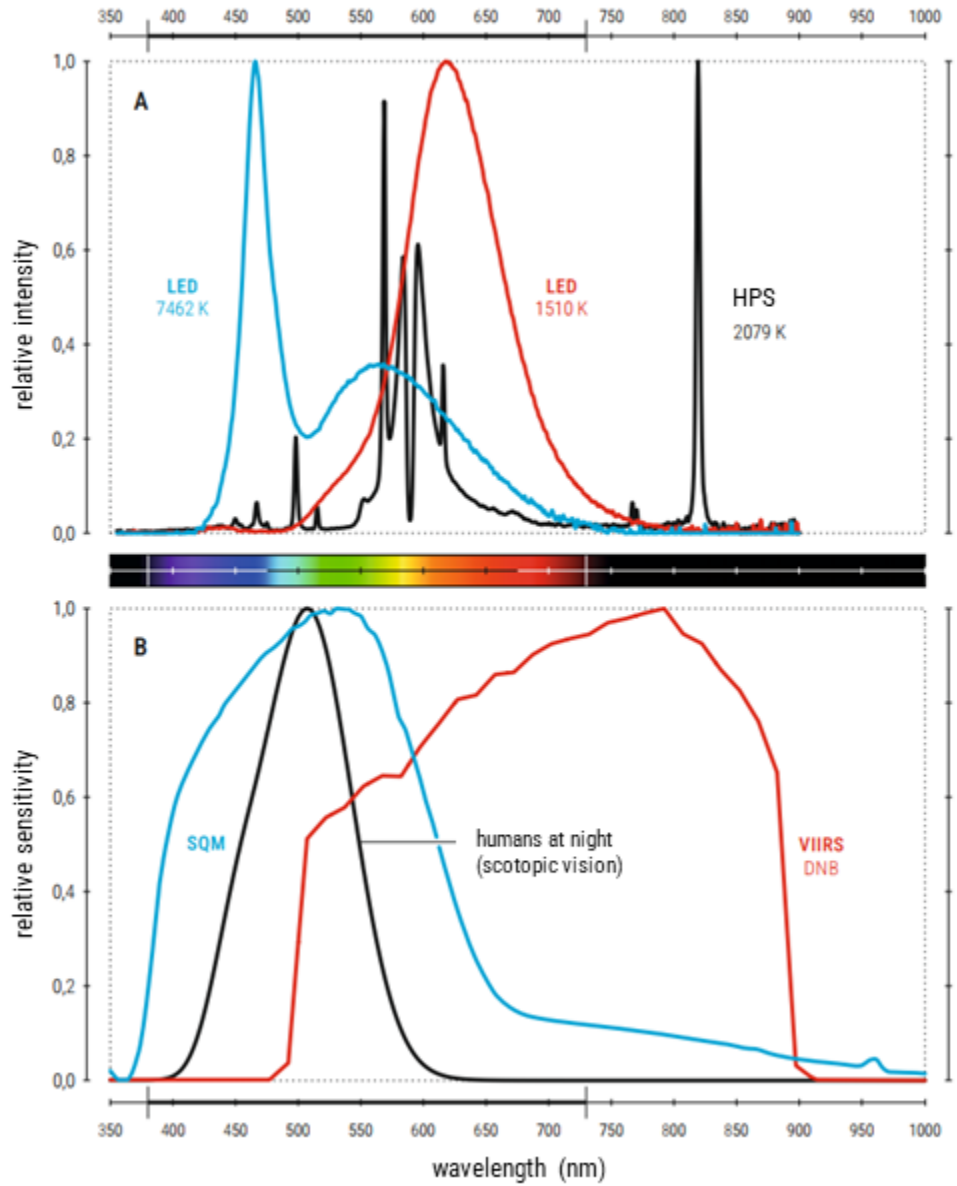
What is a satellite not telling us?

VIIRS instrument (systematic radiometric survey)

- no blue light: 500-900 nm vs 380-780 nm
- only observes at ~01:30 UTC
- moderate resolution of 740 m/pixel

Other sensors (sporadic campaign)

- RGB photo/video at fine spatial resolution
- no radiometry, uncertain calibration
- mostly experimental, limited access to data



Loss of the night sky

Vienna, Austria

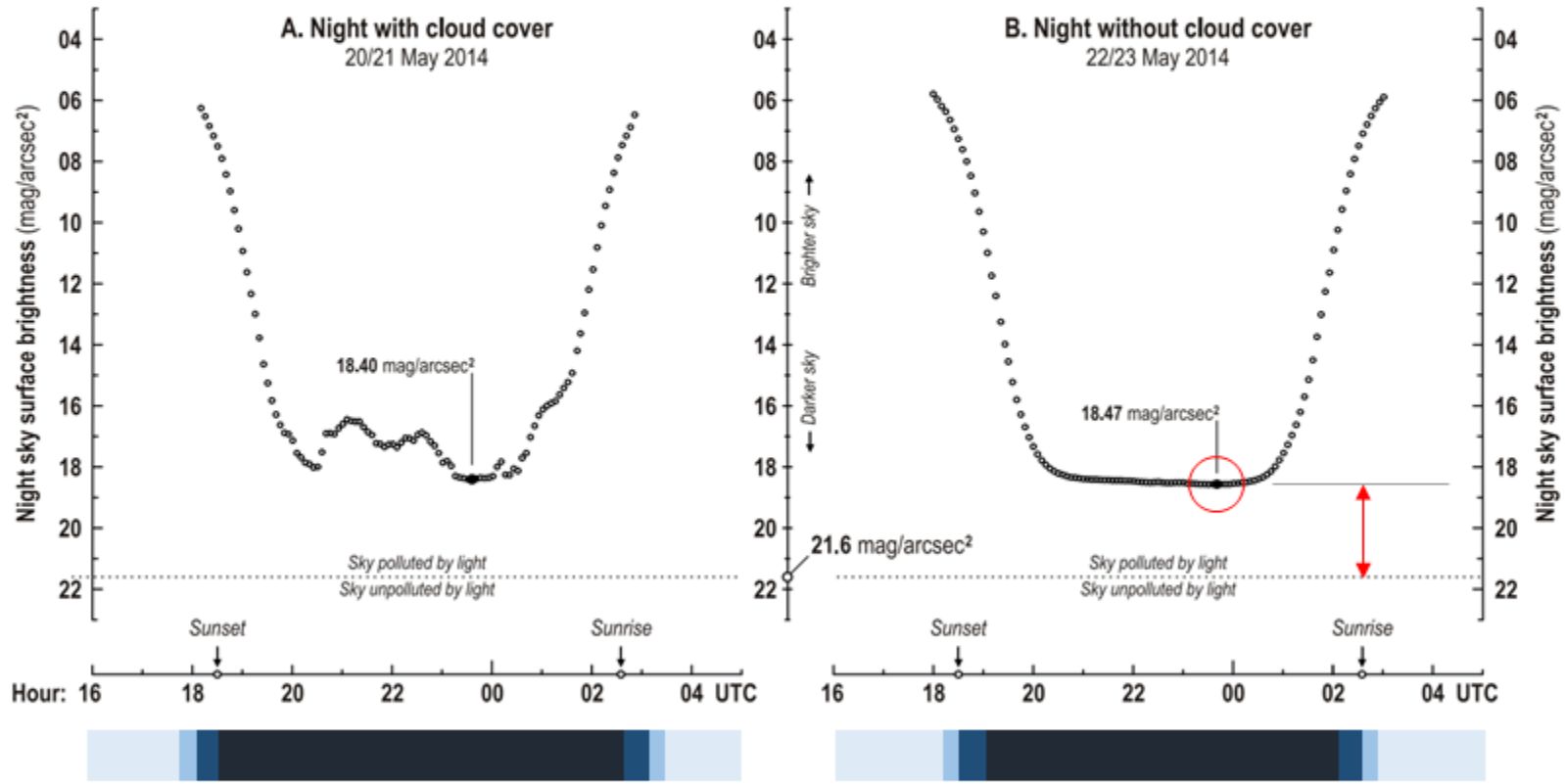
Western Mongolia

Source: Georg Zotti

Loss of the night sky

Night sky photometry

Source: alps.astro.uni.wroc.pl

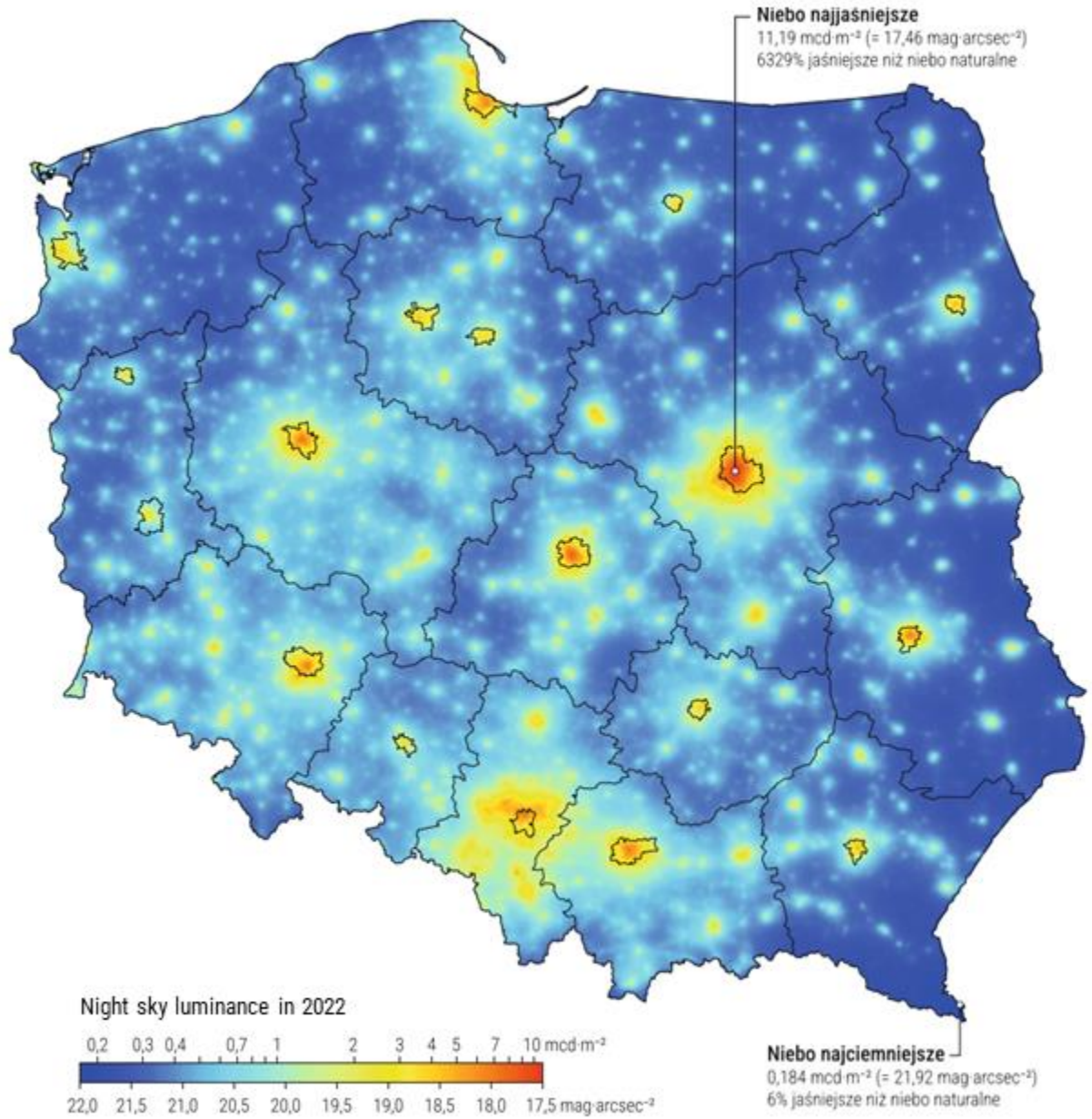


Source: Kotarba et al. 2019

Loss of the night sky

Garstang–Cinzano model applied to VIIRS data

- no natural night sky over Poland in 2022
- on average 145% brighter than natural
  from 6% (Bieszczady) up to 6329% (Warsaw)



Loss of the night sky

Garstang–Cinzano model applied to VIIRS data

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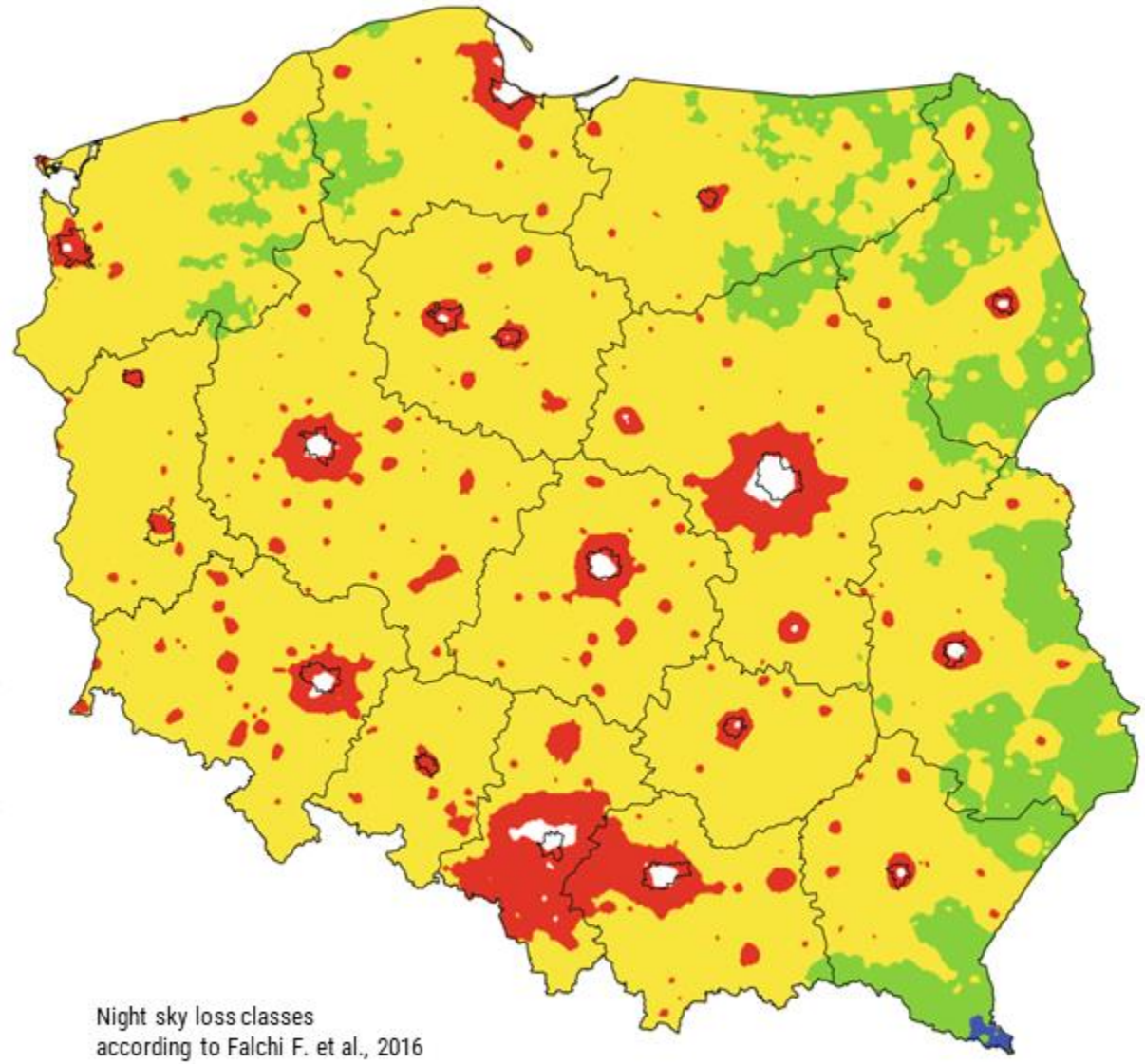
- Milky Way not visible for 58% of Polish population (9% of Polish teritory)
- no adaptation for night vision (scotopic) for 20% of Polish population



Night sky loss classes
according to Falchi F. et al., 2016

What do we miss?

(too) Simple devices (SQM)

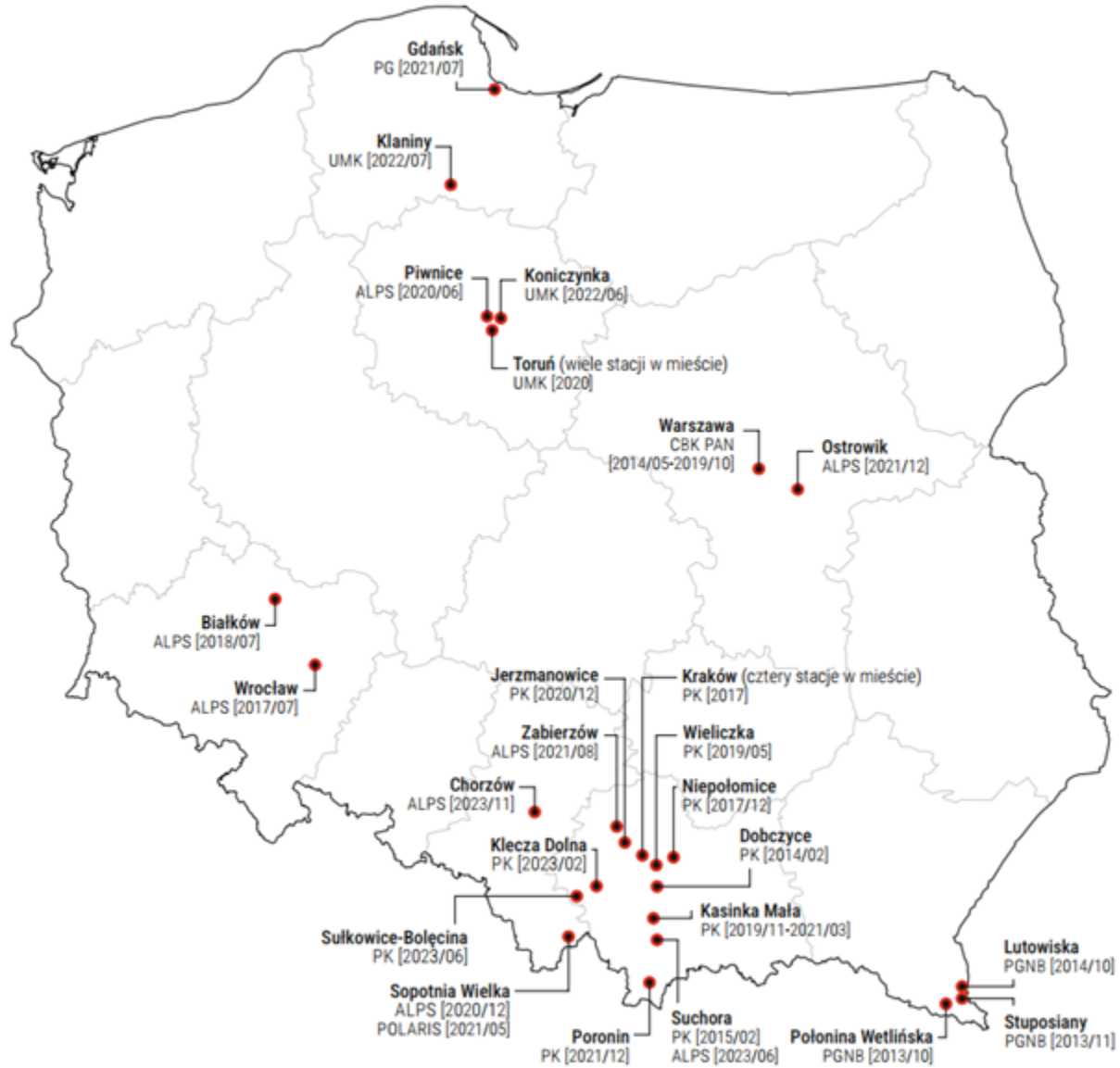
- for popular astronomy (V-band, not human eye)
- unit-to-unit variation in sensitivity
- unstable over time, no calibration standards

Network

- sparse and not coordinated measurements
- only at-nadir measurements

Model with limitations

- assumes the atmosphere with no clouds
- single function of directional light emission
- VIIRS as input; no topographic effects



Science: to use the existing data, and investigate the LP impact on the environment

ecology (urban, wild life), spatial planning, helth (inc. psychology), landscape studies, economy, …

Common ground for future cooperation within GeoPlanet

Methods: to develop tools and methods that will be dedicated for operational monitoring of LP

Surface-bases instruments (reliable wide-angle imaging spectrometer)

Network of surface-based instruments (key locations, standards and protocols, national service)

Light transfer model for real sky (clouds), true ecological LP

LP-dedicated remote sensing tools (drone, aircraft, satellite) for quantitative mapping of LP

Science is here and needs those improvements now.
Regulations will eventually come, and we will be in prepared for that day, if we stay ahead today.