Zero point assessment of the radiation environment – examples of a program applied in Sweden (ESS) and in Belarus (BelNPP)

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Zero Point assessment of the radiation environment

- **The purpose is to provide an independent**
  - baseline of the current radiation environment and its variability,
  - background data for diffuse long-term discharges,
  - data for reporting to authorities,
  - basis for information to the public,
  - basis for measures/improvements,
  - basis for continued research and development.

- **Uniquely only possible before commissioning**

➢ **Basis for comparison during normal operation**

Examples from ESS and BelNPP

- **European Spallation source, Lund, Sweden**
- The worlds most powerful proton accelerator ever built
  - *Energy of 2 GeV, power 5 MW*
- Start of research operation ~2023
- Neutrons are produced by spallation in a 11 tonnes large tungsten target
- Various radionuclides are produced during spallation and through neutron activation

Image: https://europeanspallationsource.se/

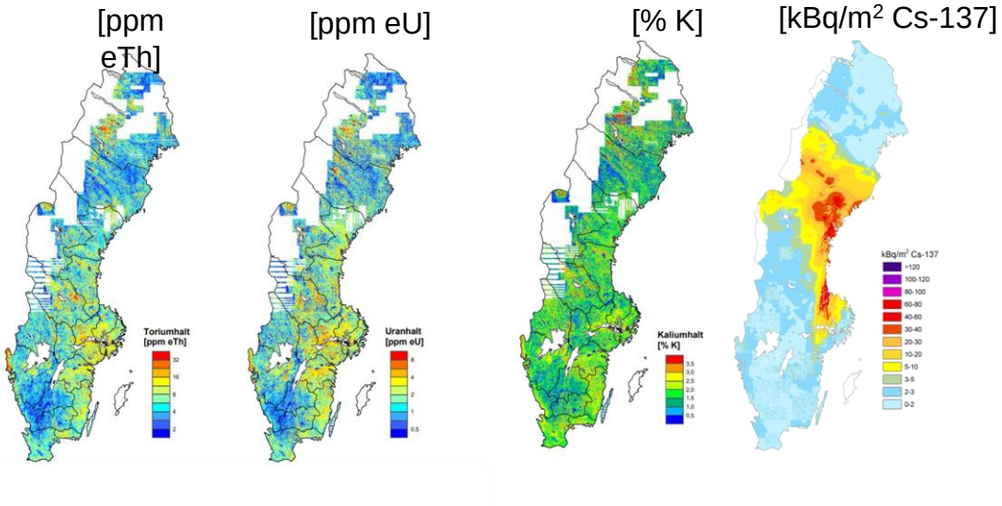
- LU contracted by ESS to establish the radiation baseline on land, air and water.

- **Belarussian nuclear power plant, Astravets, Belarus**
- First NPP in Belarus
  - *Power 2×1194 MW*
- Reactor 1 is supposed to be commissioned in 2019, the second one in 2020
- Based on VVER-1200 reactors

- Research cooperation project financially supported by SSM, for the research consortium LU, IRH, IRB to carry out an independent Zero Point baseline

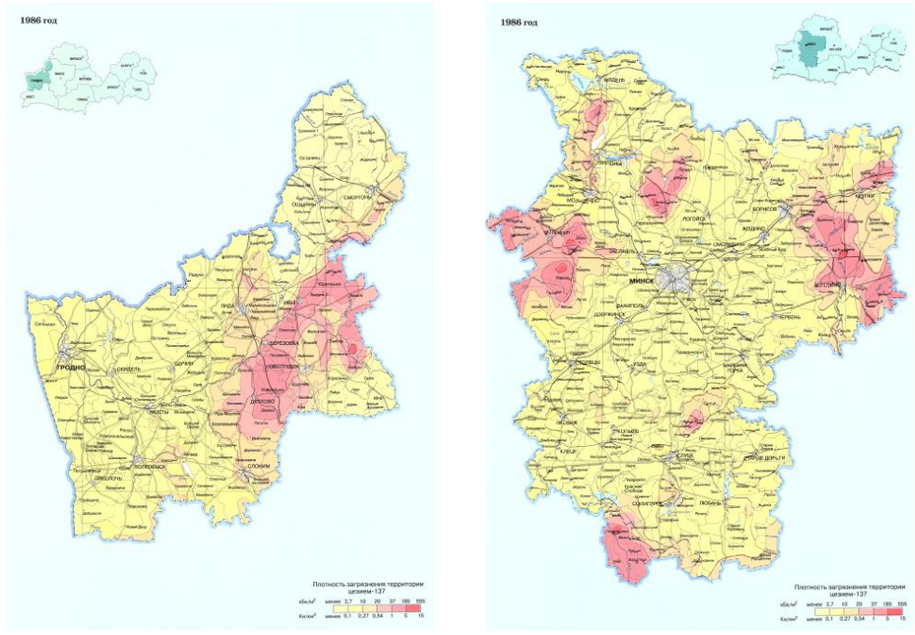
The current radiation environment – natural and anthropogenic radioactivity

- **The varying external radiation is (mainly) composed of:**
  - Radioactive substances ^{232}Th, ^{235}U, ^{238}U, ^{40}K…
  - Fallout
  - Discharges from *e.g.* hospitals/research
  - Cosmic radiation



From: Pål Andersson et al., Strålmiljön i Sverige, SSI Report 2007:02 (data from SGU)

[kBq/m^2 Cs-137 in Grodna and Minsk regions in 1986]



Current Zero Point assessment prg.

- **Assessment methods have been developed within the cooperation: LU, IRH, IRB**
  - *Previously applied in Gomel (for ^{137}Cs determinations)*
  - In 2017-2018 the program was first implemented around ESS
  - In September and October, 2019, the program was realized also around BelNPP
- **The program is based on the selection of reference sites where the current radiation environment is determined for future comparison when the facilities are in operation**
- **At the reference sites and between them, various types of samples are collected and analysed for concentrations of gamma emitters, ^{3}H and ^{14}C**

The Lund and the Astravets areas

- **Factors to consider when selecting sites**
  - Preferably sites that will remain “untouched” for decades
  - Current population density (inhabited areas)
  - Wind and geography
  - (Others´s reference points for comparison)

Area around ESS

Area around BelNPP

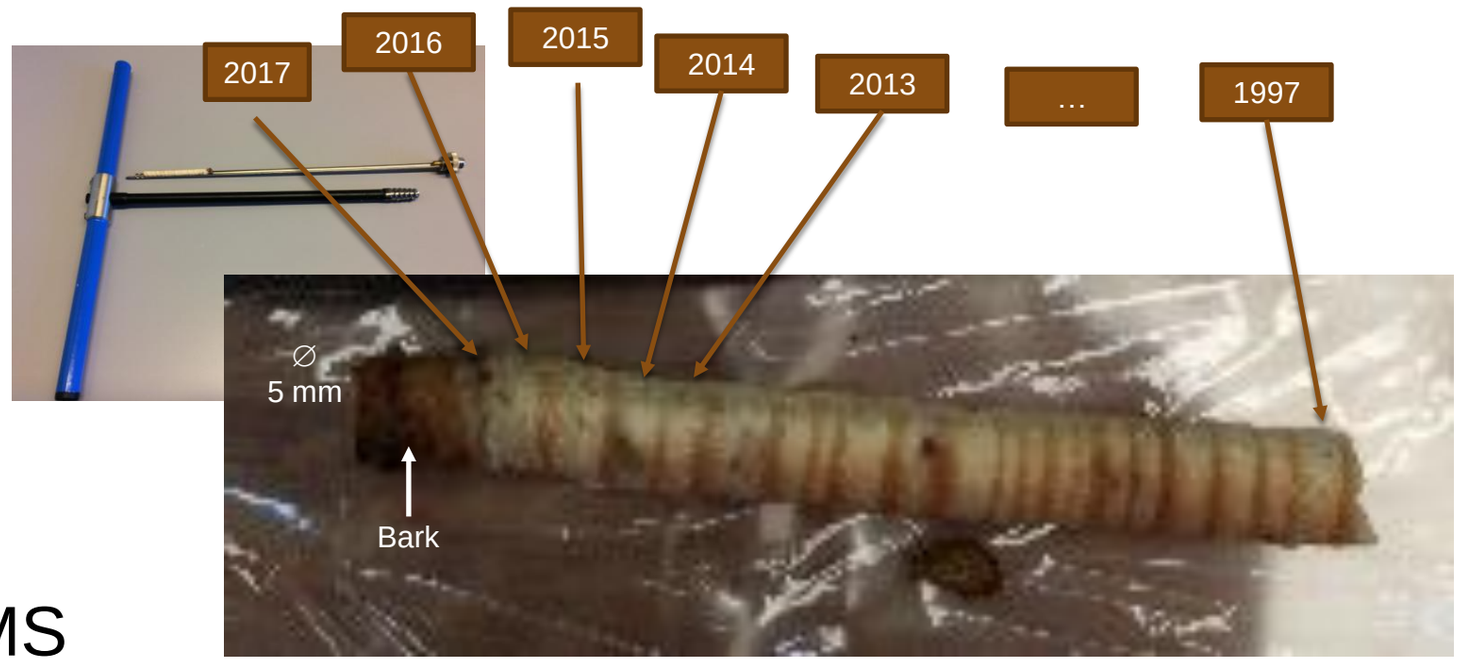
Selection of reference sites

- **Several sites are defined, about 40x40 m^2, within the area of interest. At each site:**
  - Gamma radiation dose in air is assessed by OSLD; *in situ* high-resolution gamma spectrometry; measurement of ambient dose equivalent rate (stationary and mobile)
  - The radionuclide concentration in ground is assessed by soil samplings down to 20-25 cm (divided into smaller layers); and down to about 7 cm, to determine the vertical and horizontal activity distributions, sampling of 1 m^2 grass

Equipment

- **Gamma detectors**
  - HPGe detector(s) (N_2 and electrical cooling)
  - NaI(Tl) stationary detector, 63mmx63mm (Atomtex)
  - NaI(Tl) and La_2Br_3 mobile detectors (by foot and car)
  - Automess, organic scintillator for H*(10)
  - Dosemeters, OSLD from NaCl, dose rate in air over time
  - Mobile laboratories

- **Sampling devices for**
  - Soil, grass, bioindicators, crops, water, sewage sludge, tree rings



- **Laboratory resources**
  - HPGe detectors, LSC, AMS

Assessments at the reference sites

Implementation of the Zero Point program around ESS

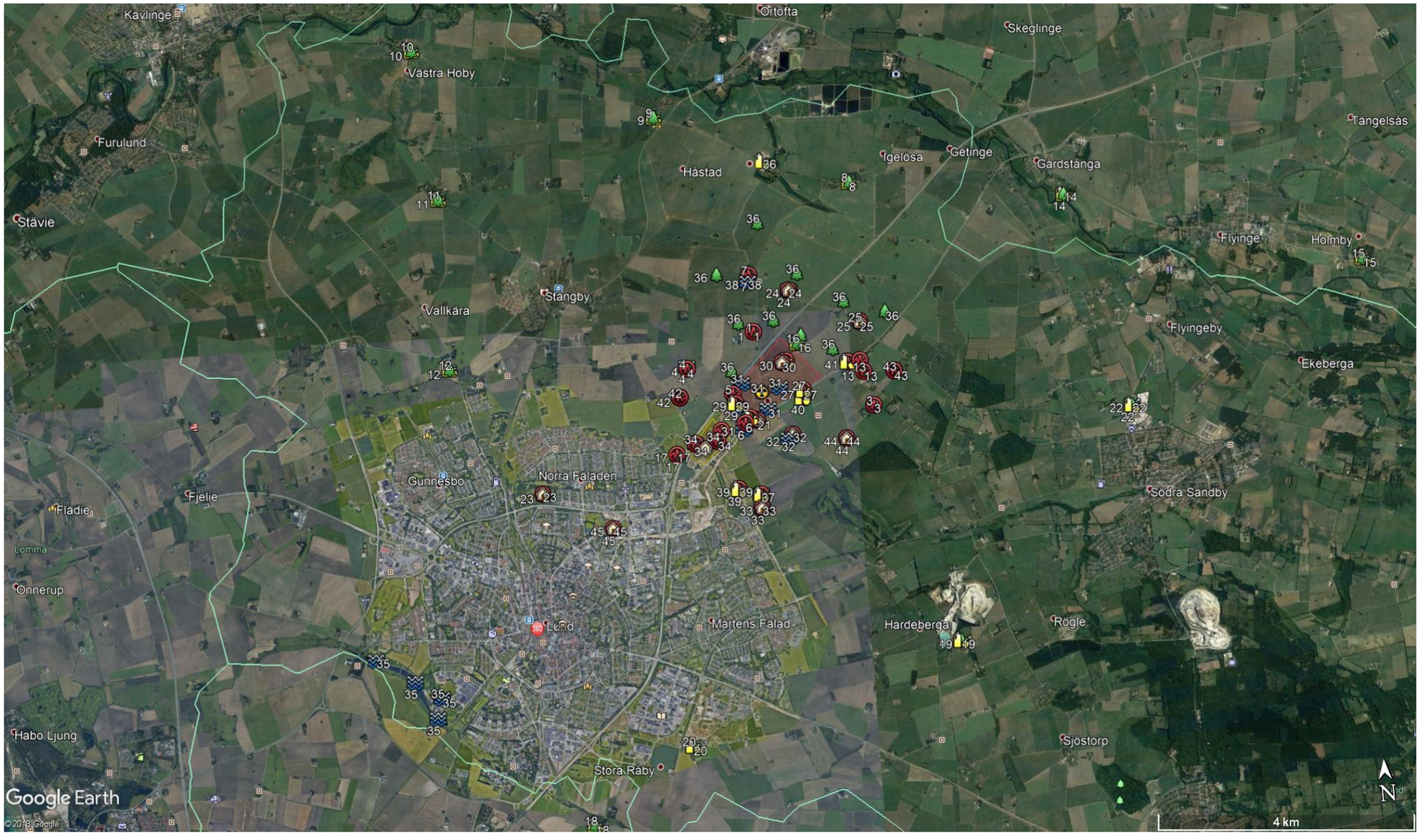
- Selection of reference sites for assessment of ambient dose equivalent rate, gamma spectrometry, soil and grass sampling

Implementation of the Zero Point program around ESS

- Selection of sites between the reference sites for samplings

Implementation of the Zero Point program around ESS

- Selection of sites between the reference sites for samplings



Implementation of the Zero Point program around ESS

- **Selection of sites between the reference sites for samplings of:**
  - crops, bioindicators (moss, spruce needles, lichen), milk animal feed, ensilage, sewage sludge for analysis of gamma emitting radionuclides
  - ground water (drilled holes), surface water (ponds), private wells, water in sewage sludge, milk, beet root for analysis of ^{3}H
  - Grass, moss, crops, fruits, milk, tree (annual rings) for analysis of ^{14}C

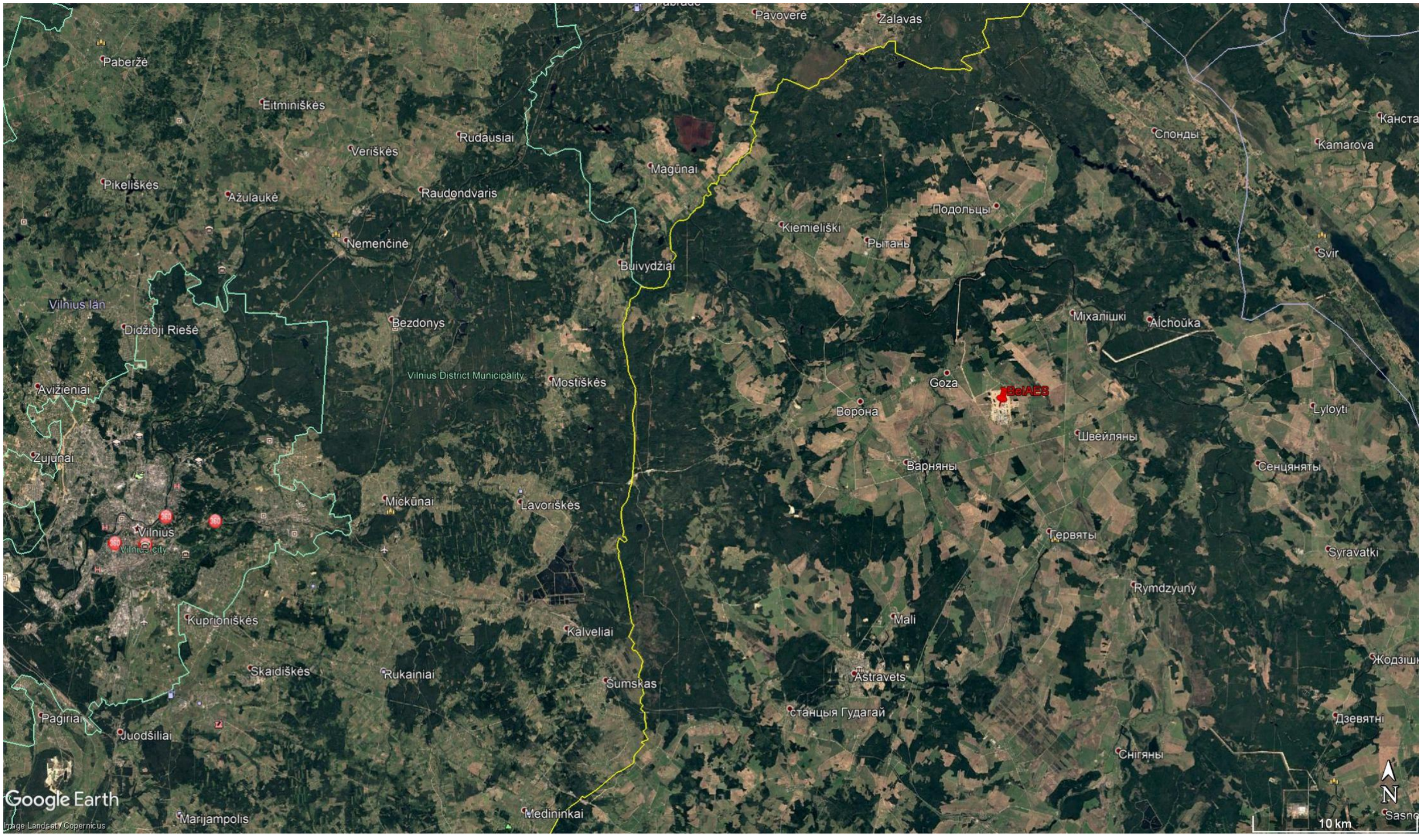




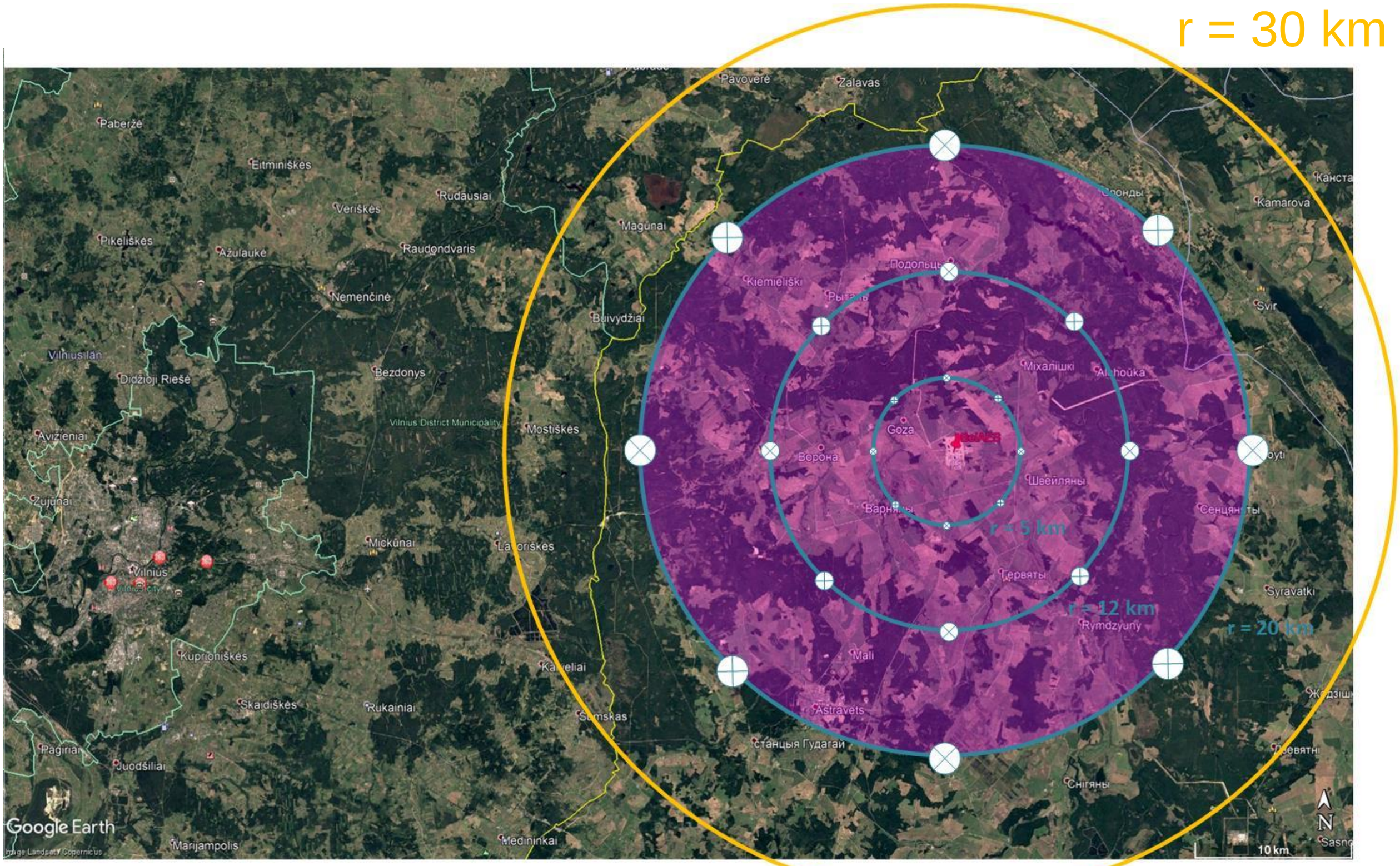


Implementation of the Zero Point program around BelNPP

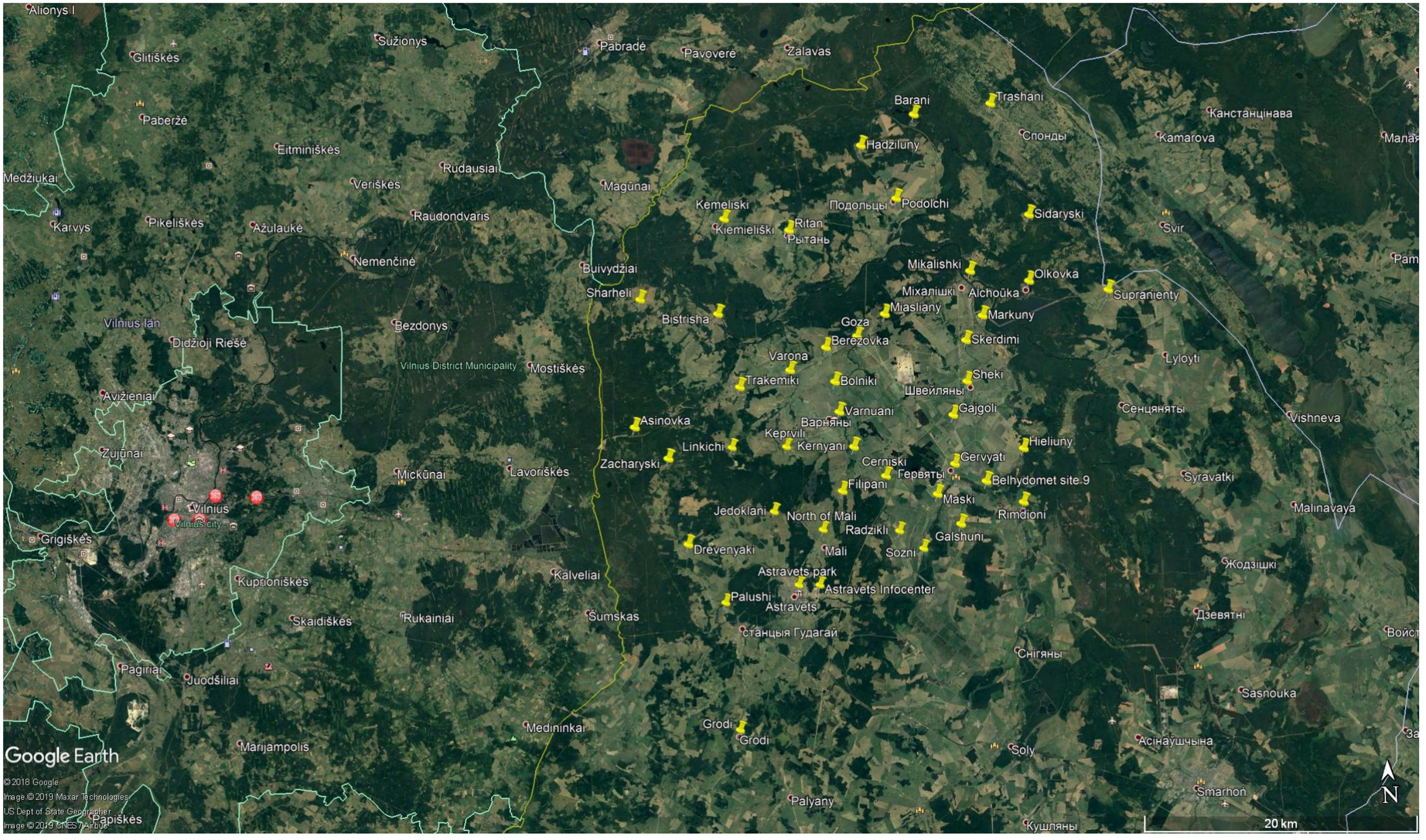
Implementing the Zero Point program around BelNPP



Implementing the Zero Point program around BelNPP



Implementing the Zero Point program around BelNPP



Implementing the Zero Point program around BelNPP

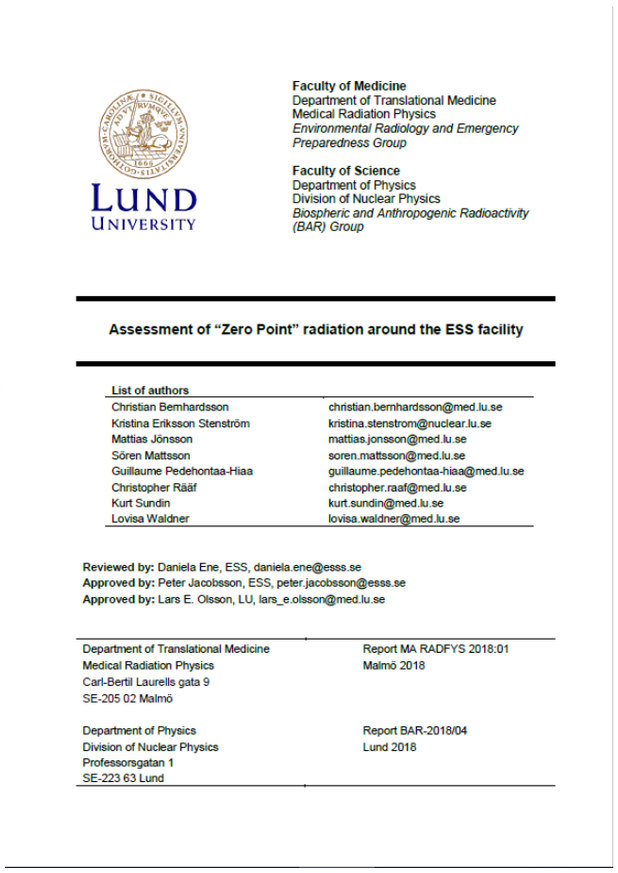
- **First expedition 16-20 September**
  - *In situ* gamma spectrometry
  - Dose rate in air: stationary
  - Dose rate in air: NaCl dosemeters
  - Soil samplings (deep cores)
  - Sampling of water for analysis of ^{3}H
  - Tree rings for analysis of ^{14}C

- **Second expedition 15-17 October**
  - Same as during the first expedition (more reference sites)
  - Fruit, mushrooms, ~~milk~~, crops, bioindicators (analysis of gamma emitters, ^{3}H and ^{14}C)
  - ~~Sewage sludge (analysis of gamma emitters and ^{3}H)~~

Results of ZP around ESS

- **Small and expected variations were observed for natural occurring radionuclides in the ground**
  - No unexpected gamma emitters were found in the samples (some were found as expected in sewage sludge)
- **The ^{3}H levels were below the minimum detectable activity (except for two samples of sewage sludge)**
- **The sampling sites showed no signs of local anthropogenic contamination of ^{14}C**

Full report



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Assessment of "Zero Point" radiation around the ESS facility

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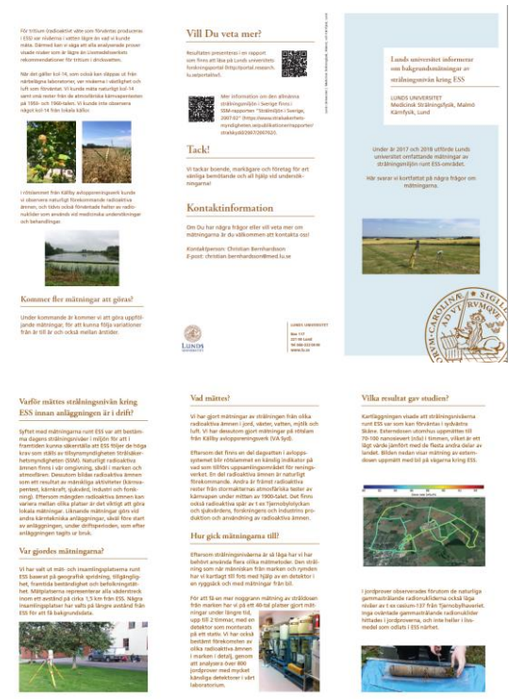
Report BAR-2018/04
Lund 2018

https://portal.research.lu.se/portal/files/57600811/ESS_Zero_Point_public_190204.pdf

Popular scientific report



Vill Du veta mer?

Tack!

Kontaktinformation

Kommer fler mätningar att göras?

Lunds universitet informerar om bakgrundsmätningar av strålningsnivån kring ESS

Vilka resultat gav studien?

http://www.nuclear.lu.se/fileadmin/nuclear/14C_AMS/2-viksfolder_web.pdf

Results of ZP around BelNPP

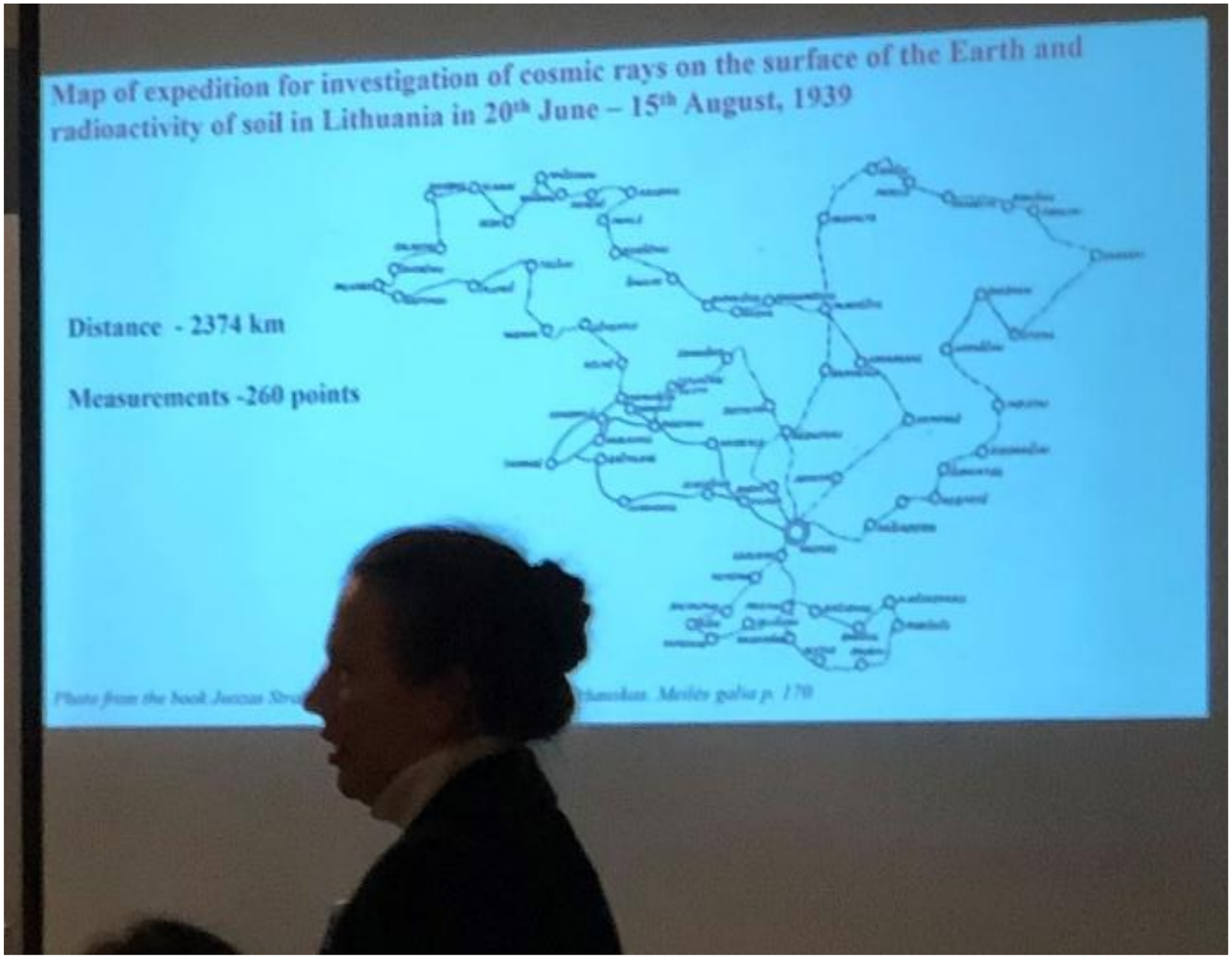
- 45 reference locations have been assessed for *in situ* gamma spectrometry (stationary and mobile), ambient dose equivalent rate in air, soil and grass sampling
- More than 400 samples have been collected for analysis of gamma emitters, ^{3}H (water, fruits, vegetables), ^{14}C (fruits, vegetables)
  - All samples collected are to be measured and analysed at Lund University (medical radiation physics and nuclear physics)
  - Samples for intercomparisons between the consortium laboratories and Belhydromet has been collected as well

Next steps

- **ESS**
  – Continuation of the Zero Point program
- **BelNPP**
  – Zero Point assessment expedition to Lithuania, close to the boarder to Belarus (and up towards Ignalina), *spring 2020*
  – Information campaign for relevant stakeholders (including the public), *summer 2020*
    - Sampling of important foodstuff that was unavailable in autumn 2019
  – Collection of OSLD and re-assessments of the reference sites during the start-up of reactor 1 and then 2
  – Continued re-assessments during the operation of BelNPP, intercomparisons with other laboratories

Previous similar assessments?

Yes!



Thank you for listening!

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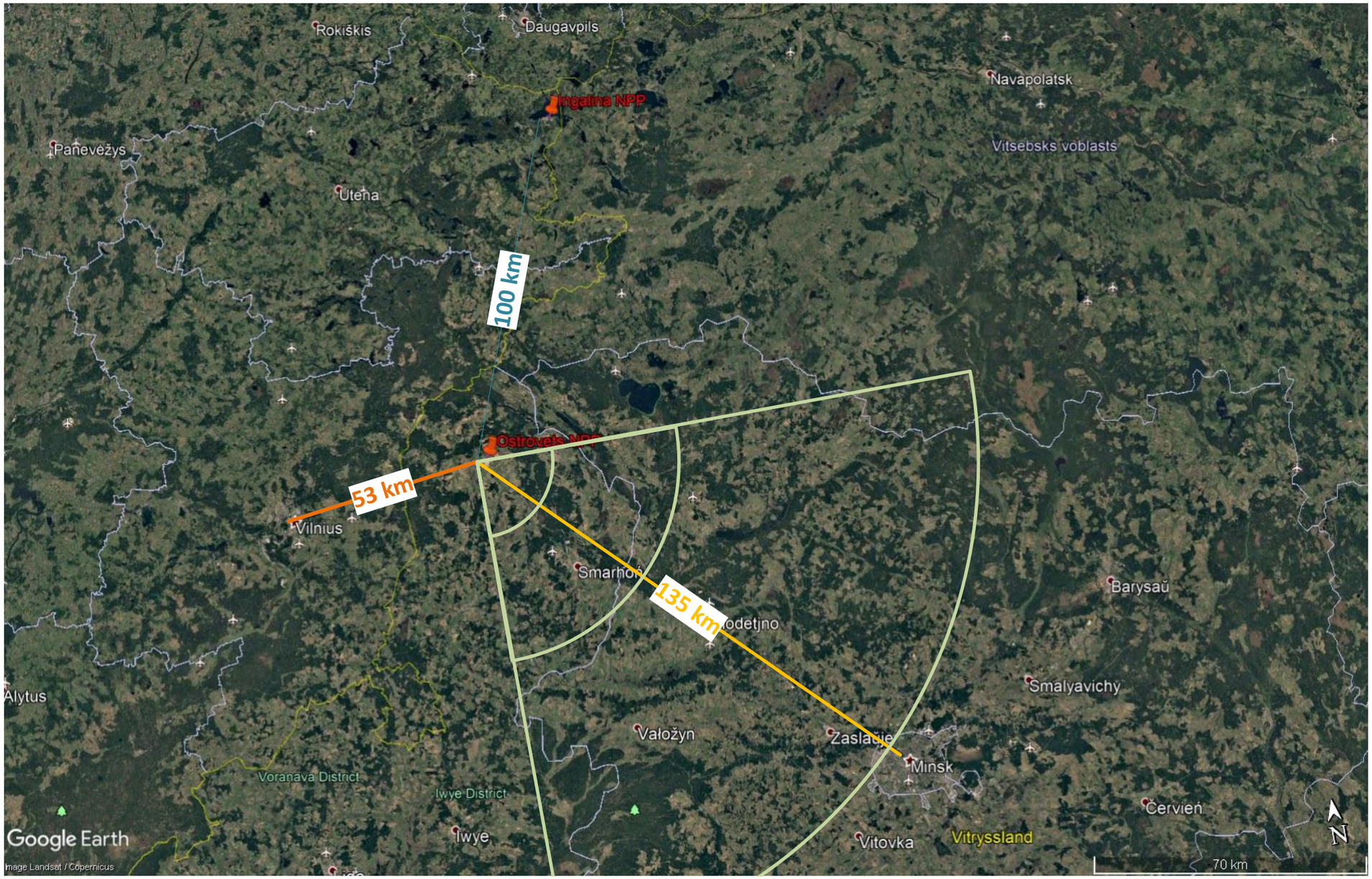
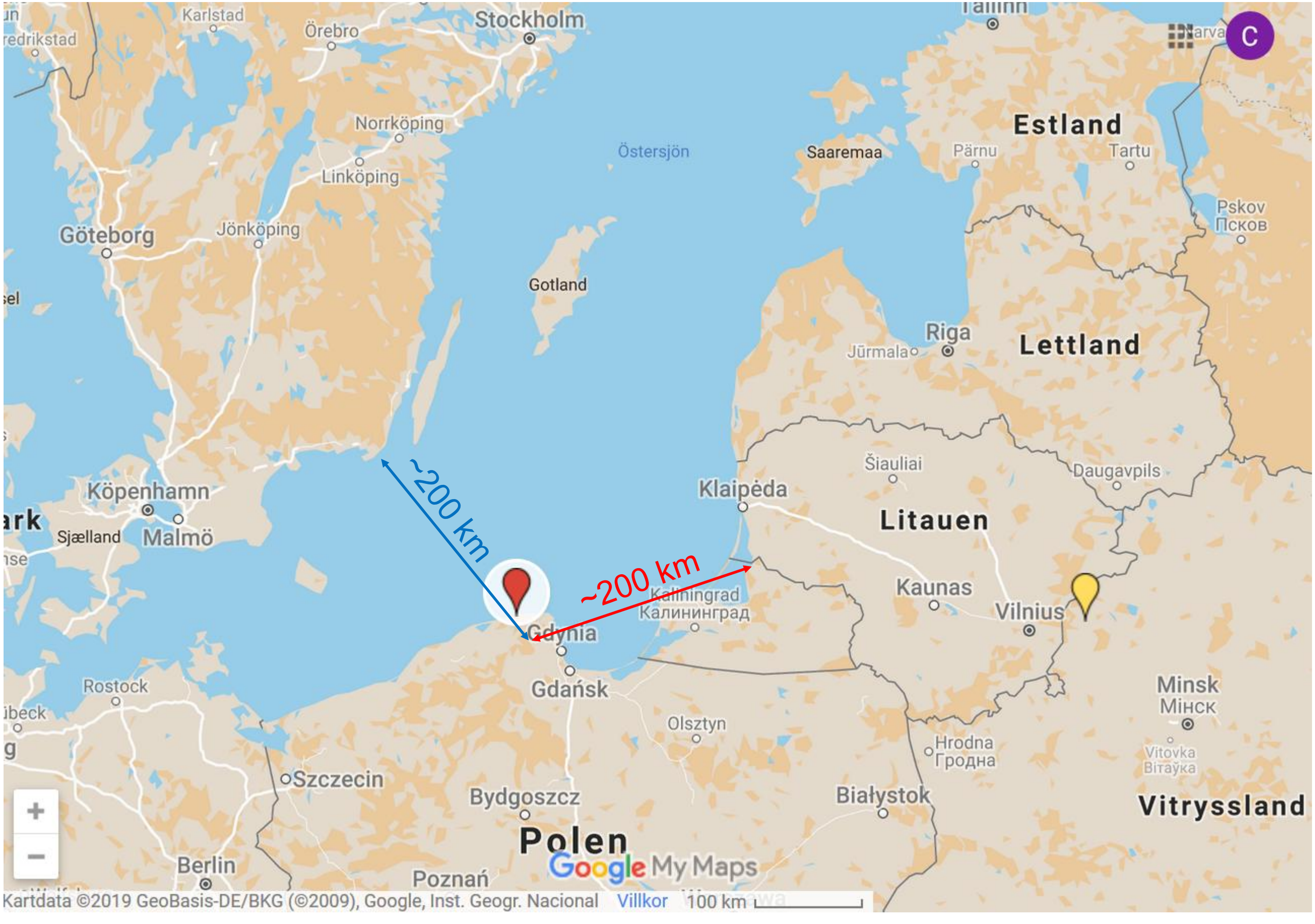
Additional points of interest

- Extend the area of interest – beyond the Astravets region



Choczewo, Poland; 2 Reactors ; Planned for 2029

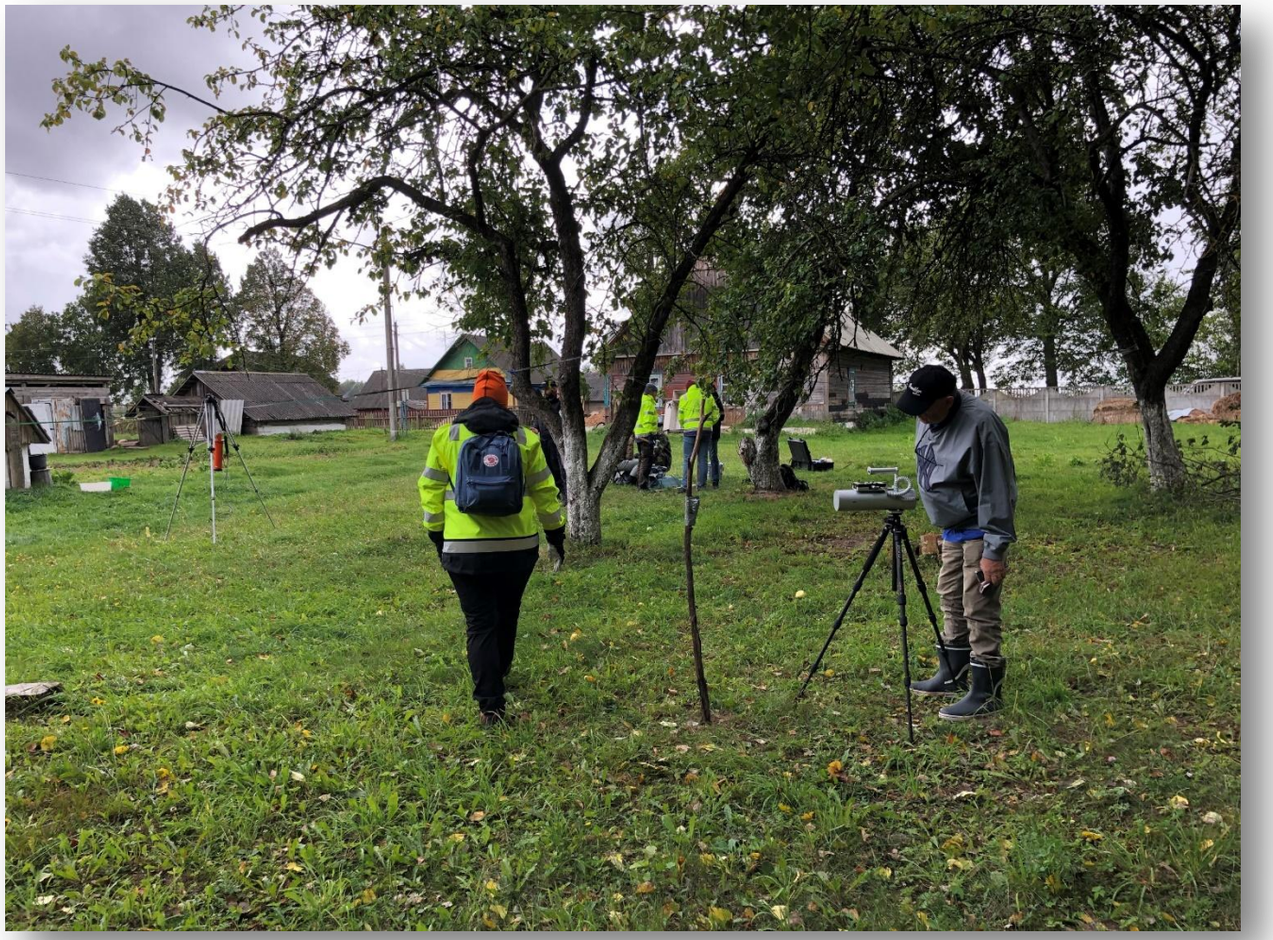


A picture says more than 1000 words

Sampling of soil

Sampling of water

Assessment of gamma dose rate and spectrometry



Sampling of trees for ^{14}C analysis

Intercomparison

Thank you for listening!