



ФЕДЕРАЛЬНОЕ ДОРОЖНОЕ АГЕНТСТВО
РОСАВТОДОР



Approaches to Improving the Geotechnical Monitoring of Highways in the Permafrost Regions of Russia

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RATIC/T-MOSAIC
January 20, 2022
18:00 GMT

Guidelines for Development and Management of Transportation Infrastructure in Permafrost Regions

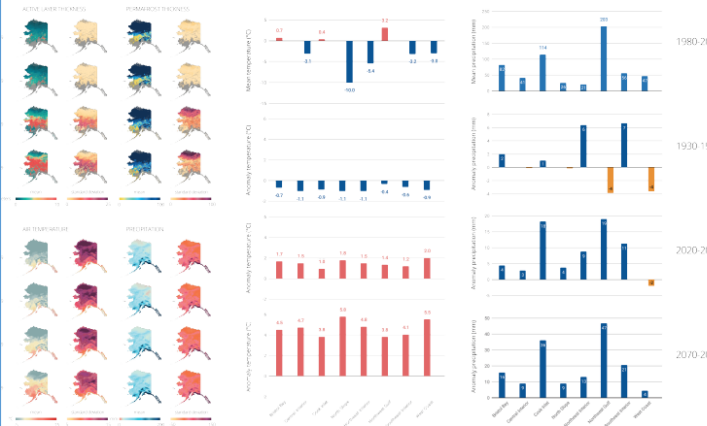


May 2010

Alaska's Transportation Infrastructure in a Changing Environment

E.D. Trochim

Alaska Center for Energy and Power - University of Alaska Fairbanks

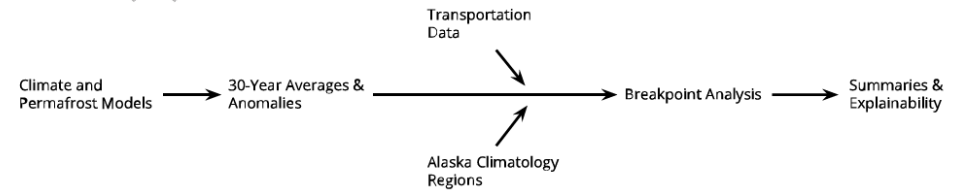


Understanding the interactions between permafrost, climate and infrastructure is complex especially in regions like Alaska. The most readily available geospatial data on permafrost and infrastructure do not readily show the interactions. This study aims to evaluate the utility of long-term permafrost and climate data in understanding and predicting infrastructure stability on permafrost for Department of Transportation (DOT) assets in Alaska.

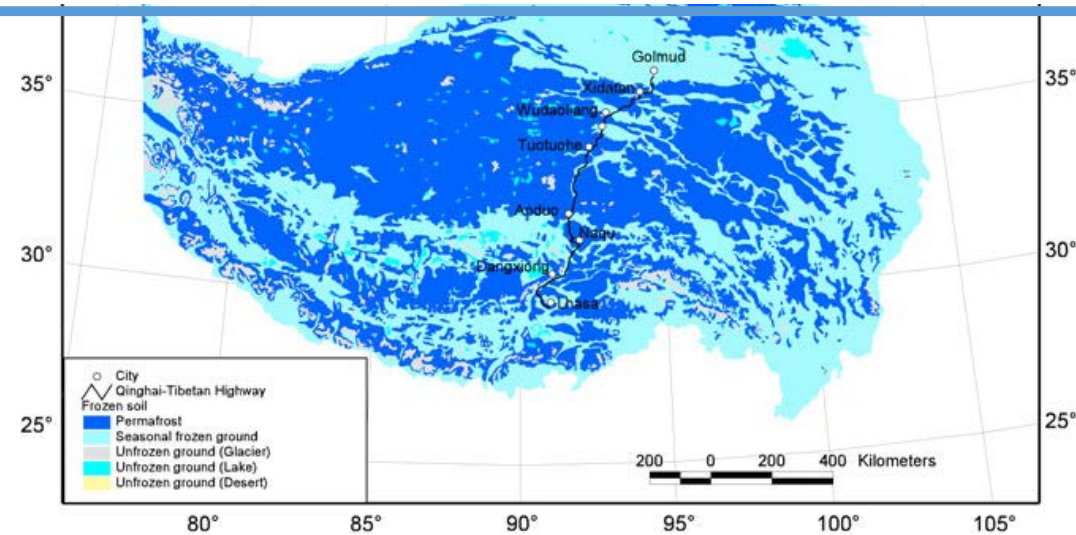
In order to explore these relationships effectively, a temporary app was developed to contrast the relationships between active layer depths, permafrost thickness, air temperature, precipitation, DOT assets (roads, bridges, airports) and the Statewide Transportation Improvement Program (STIP) projects.

This approach allows preliminary data patterns to be explored in greater detail before commencing further modeling.

Further details can be found at <https://edtrochim.users.earthengine.app/view/temporay-pf-transportation-ak>

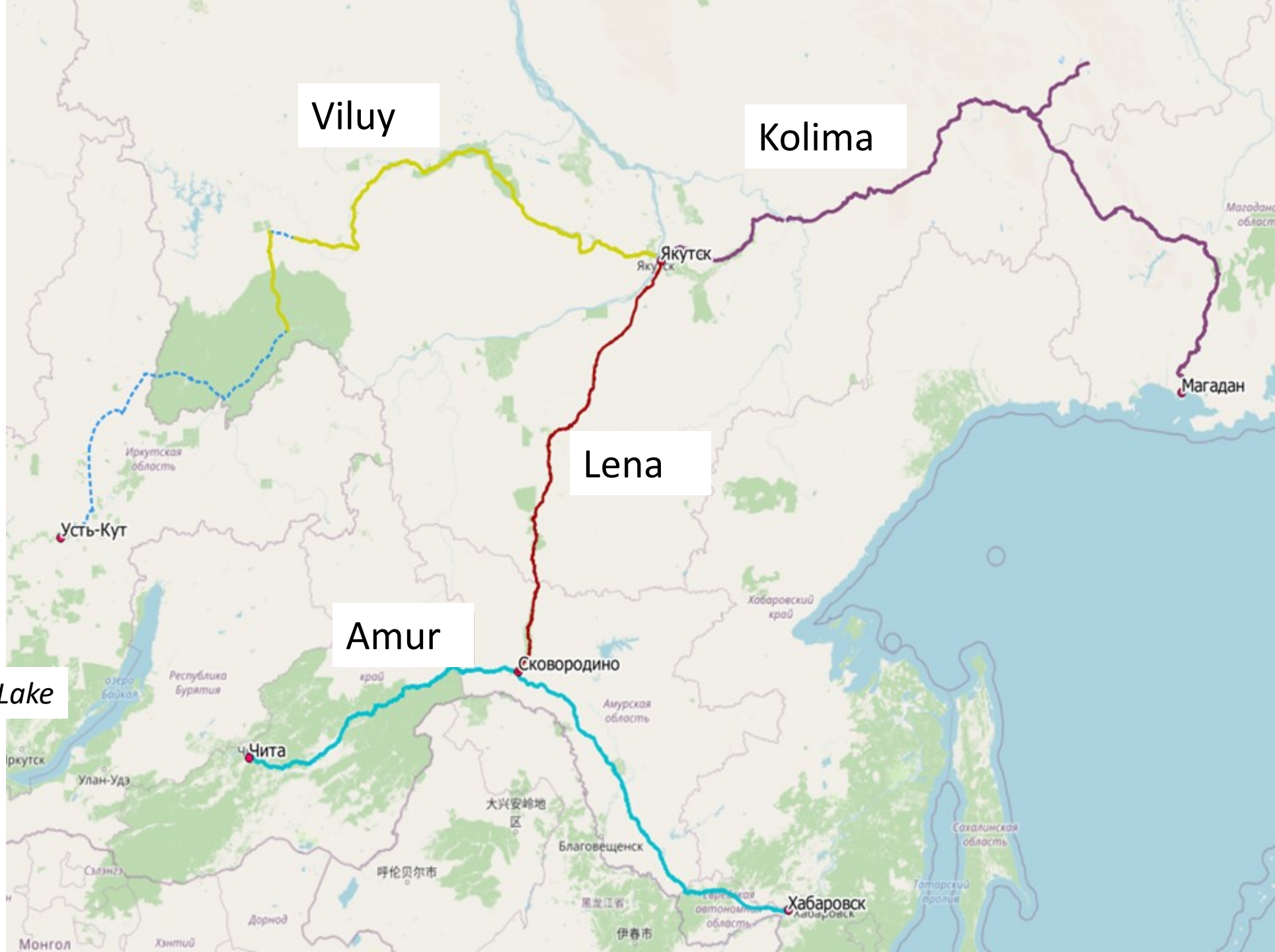


Active layer and permafrost thickness (m), temperature (°C) and precipitation (mm) over 4-30-year multidecadal periods showing mean, standard deviation values and anomaly values (right graphs). These were derived using annual GDP, a landscape scale permafrost model outputs from the Integrated Ecosystem Model (IEM) project using: 1) CRU TS 3.1 data (1980-2009); 2) 2 AMIP/CMIP3 climate model projections (2010-2100) (ccsm_cgcm3_1 and mpi_echam5) and one projected emission scenario (A1B); and 3) 1 AR5/CMIP5 climate model projection (2010-2100) (ncar_ccsm4) and one projected emission scenario (RCP 8.5).



Map of Permafrost on the Qinghai-Tibetan Plateau (Li and Cheng, 1996)

Baikal Lake



Viluy

Kolima

Lena

Amur

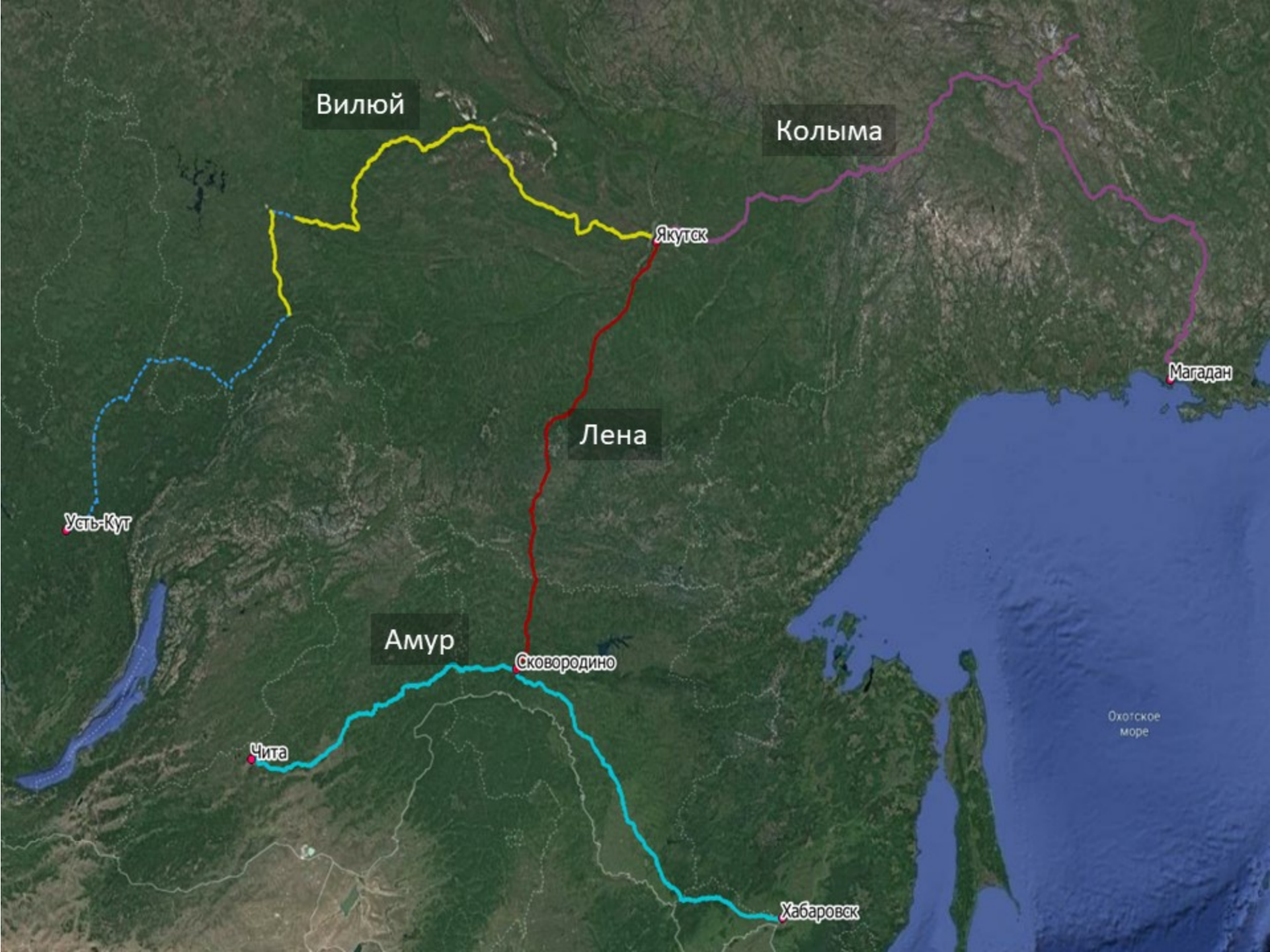
Якутск
Yakutsk

Магадан
Magadan

Сковородино
Skovorodino

Чита
Chita

Хабаровск
Khabarovsk



Виллюй

Колыма

Якутск

Магадан

Лена

Усть-Кут

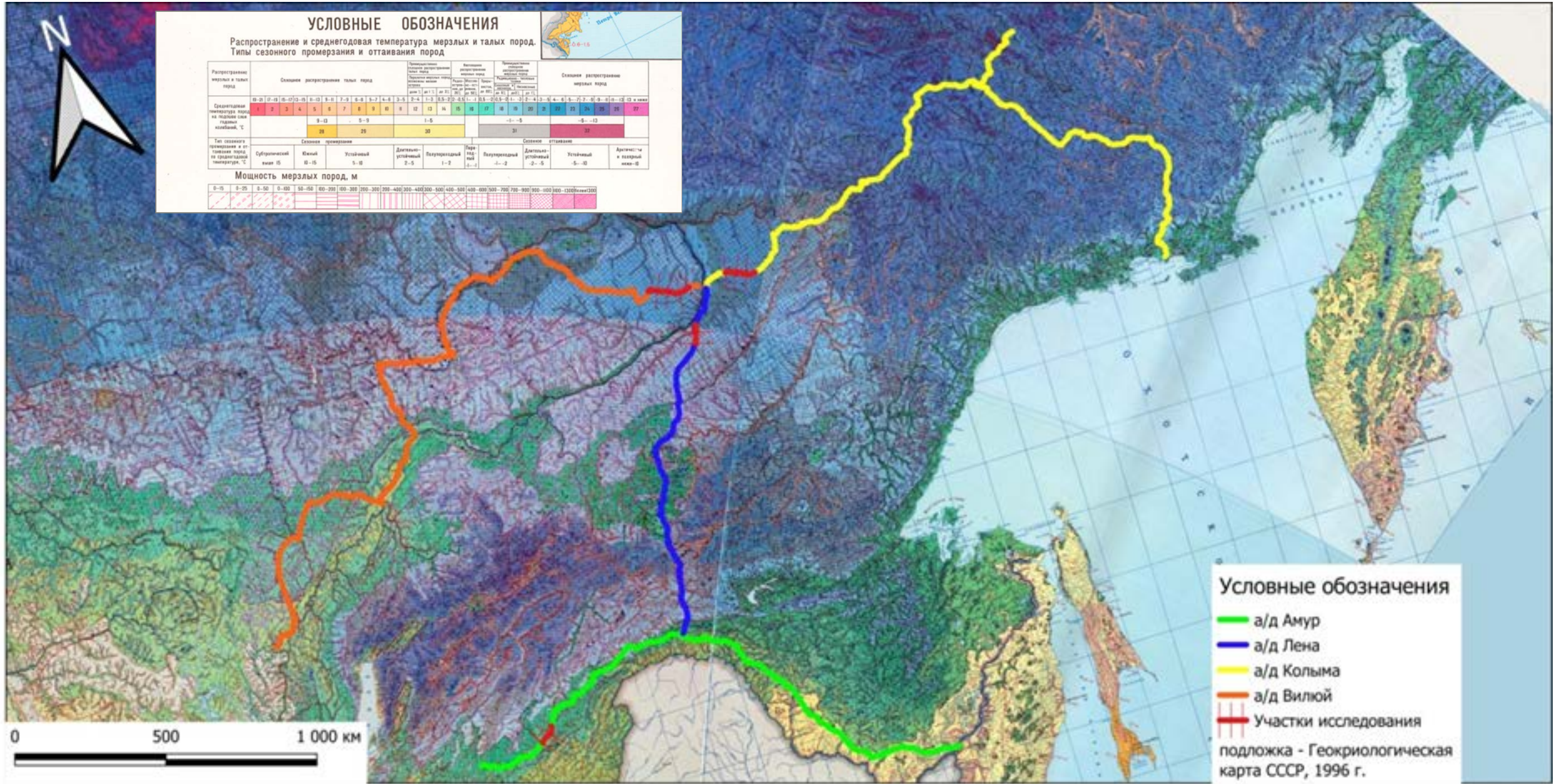
Амур

Сковородино

Чита

Охотское море

Хабаровск



УСЛОВНЫЕ ОБОЗНАЧЕНИЯ

Распространение и среднегодовая температура мерзлых и талых пород.
Типы сезонного промерзания и оттаивания пород

Распространение мерзлых и талых пород	Схемные обозначения талых пород												Схемные обозначения мерзлых пород														
	0-2	0-3	0-4	0-5	0-6	0-7	0-8	0-9	0-10	0-11	0-12	0-13		1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-13		
Среднегодовая температура пород на глубине слоя годовых колебаний, °C	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
Тип сезонного промерзания и оттаивания пород по среднегодовой температуре, °C	Субарктический холод 15			Южный 0-15			Устойчивый 5-10			Длительно-устойчивый 2-5			Полупереходный 1-2			Переходный 0-1			Длительно-переходный -1-2			Устойчивый -5-10			Арктический и холодный ниже 10		

Мощность мерзлых пород, м

0-15	15-25	25-50	50-100	100-200	200-300	300-400	400-500	500-600	600-800	800-1000	1000-1200	1200-1500	1500-2000	2000-3000	3000-4000	4000-5000	5000-10000	10000-13000
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Условные обозначения

- а/д Амур
 - а/д Лена
 - а/д Колыма
 - а/д Вилюй
 - Участки исследования
- подложка - Геокриологическая карта СССР, 1996 г.



Photo from Alexey Zhirukhin

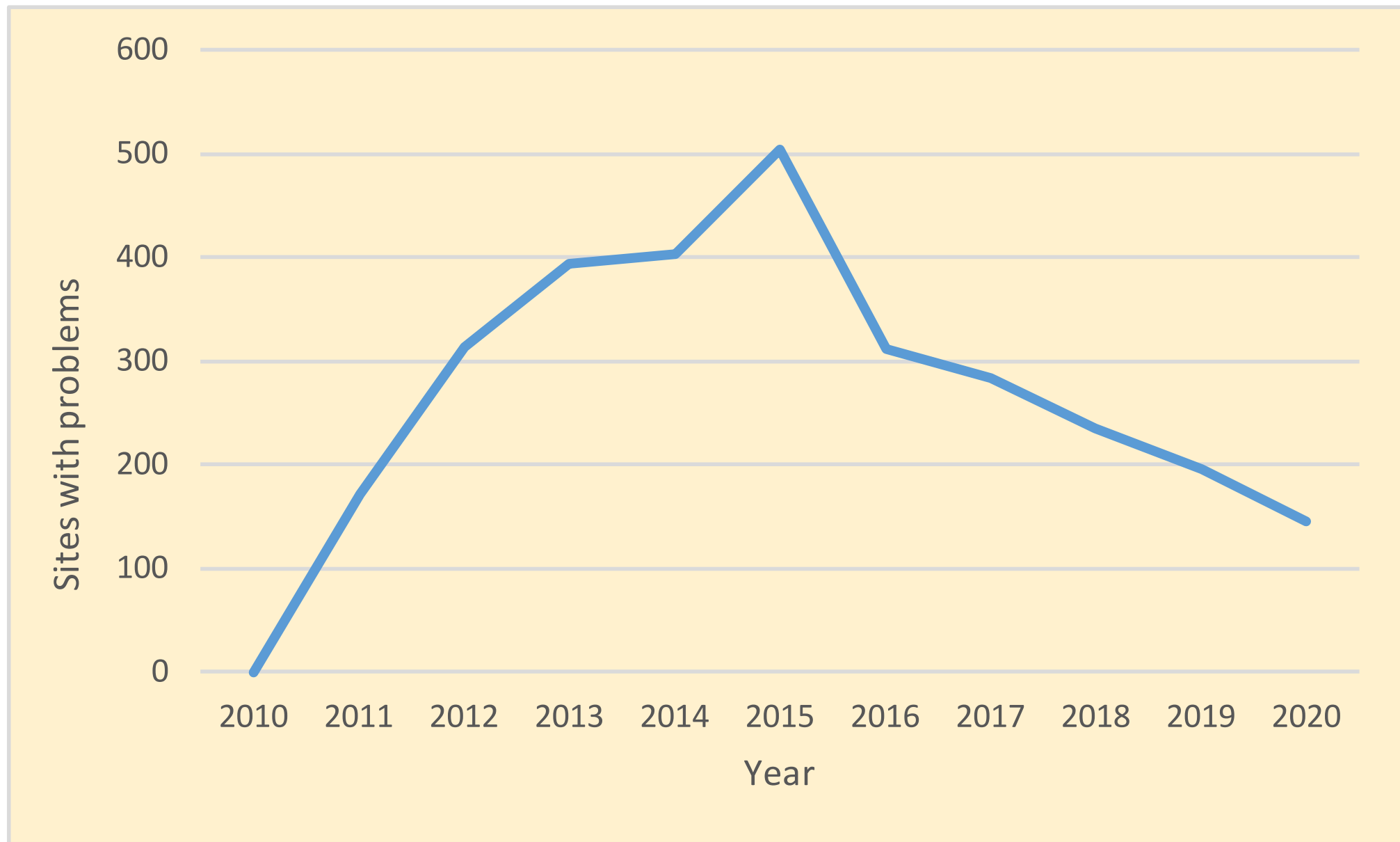
Lena Highway before and after reconstruction in 2014



Amur Highway after reconstruction in 2010



Thermal settlements cases quantity at Amur Highway after the reconstruction



The measures of engineering defense





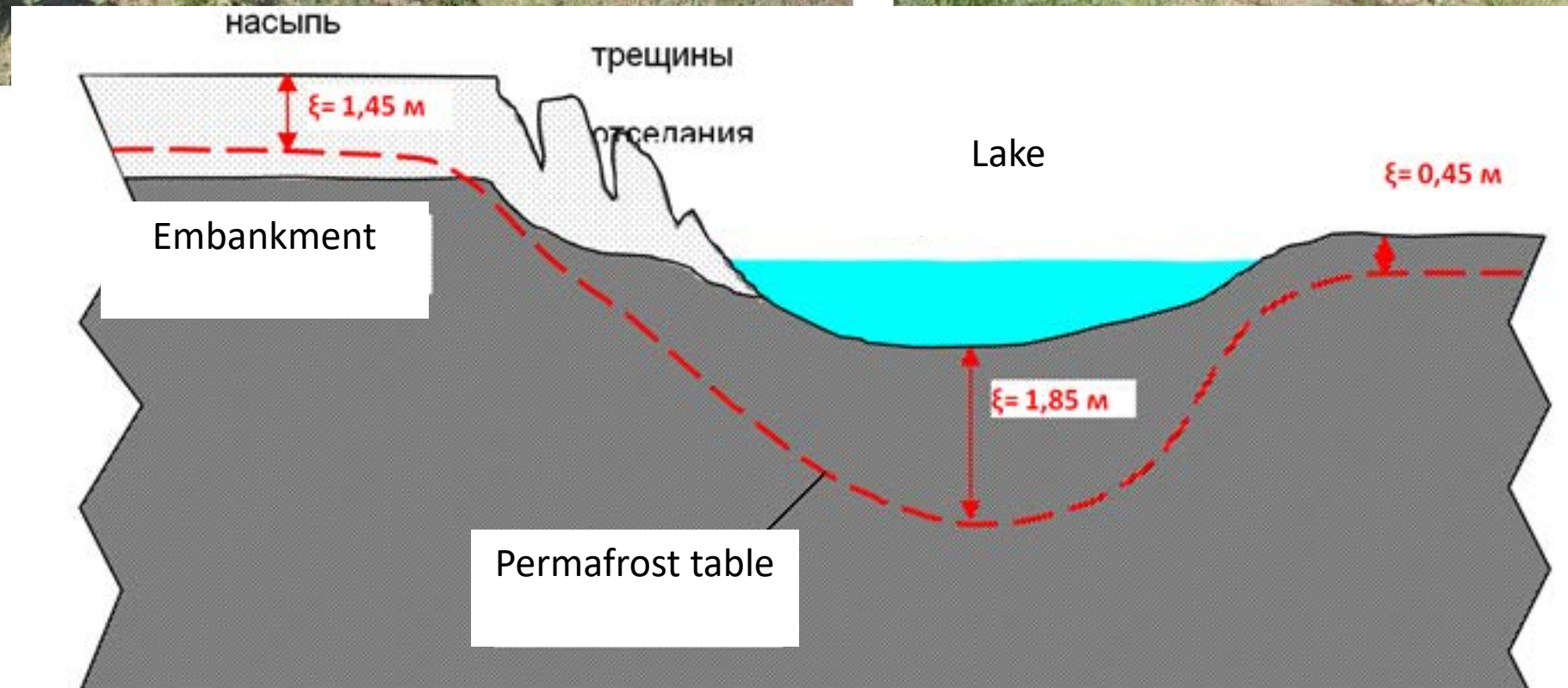


Photo from
TransEGM Ltd
archive



Seasonal ice blister (April, 2011)

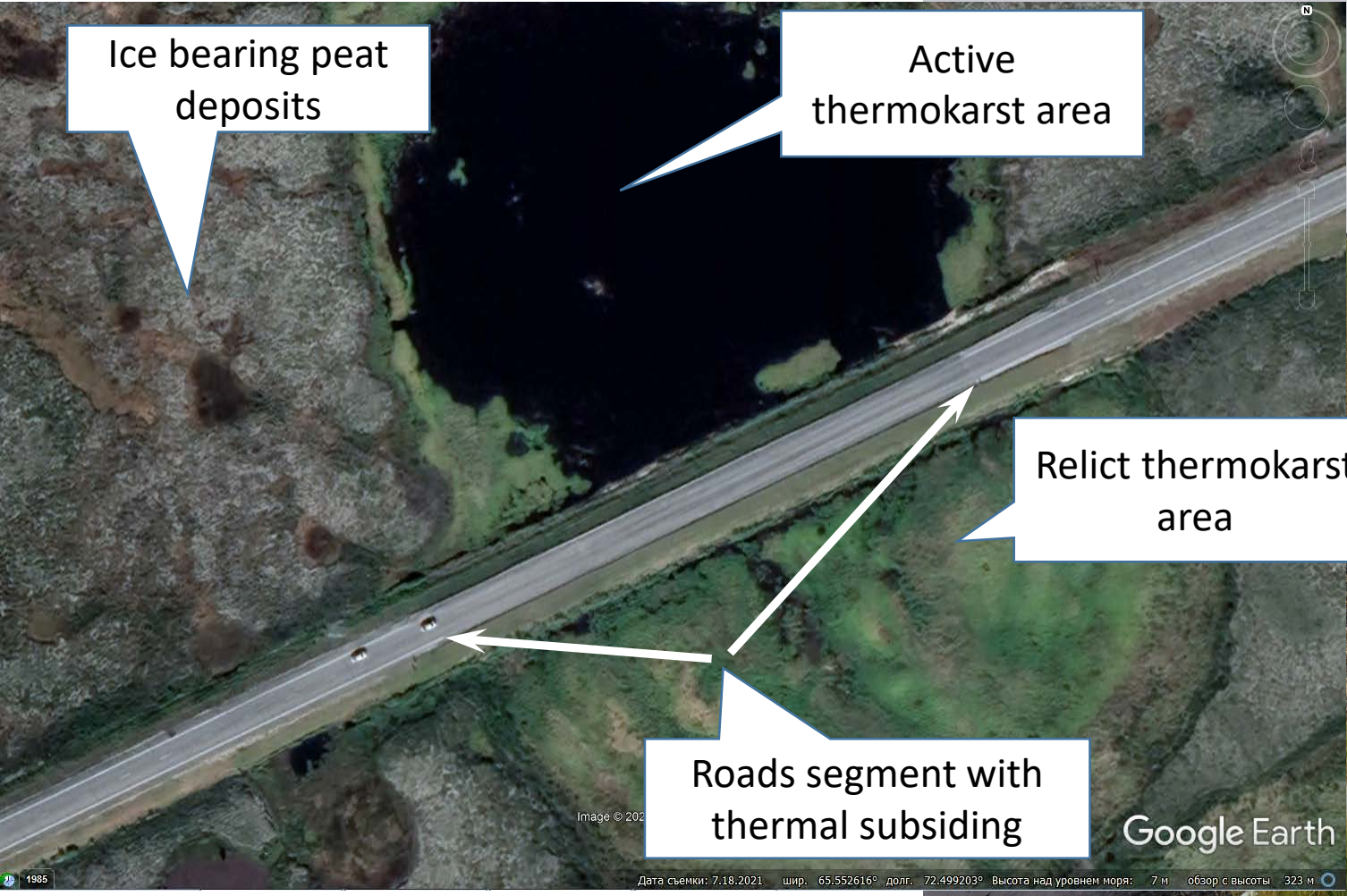
Photo from
TransEGM Ltd
archive



River icing with ice blister

Photo from
TransEGM Ltd
archive

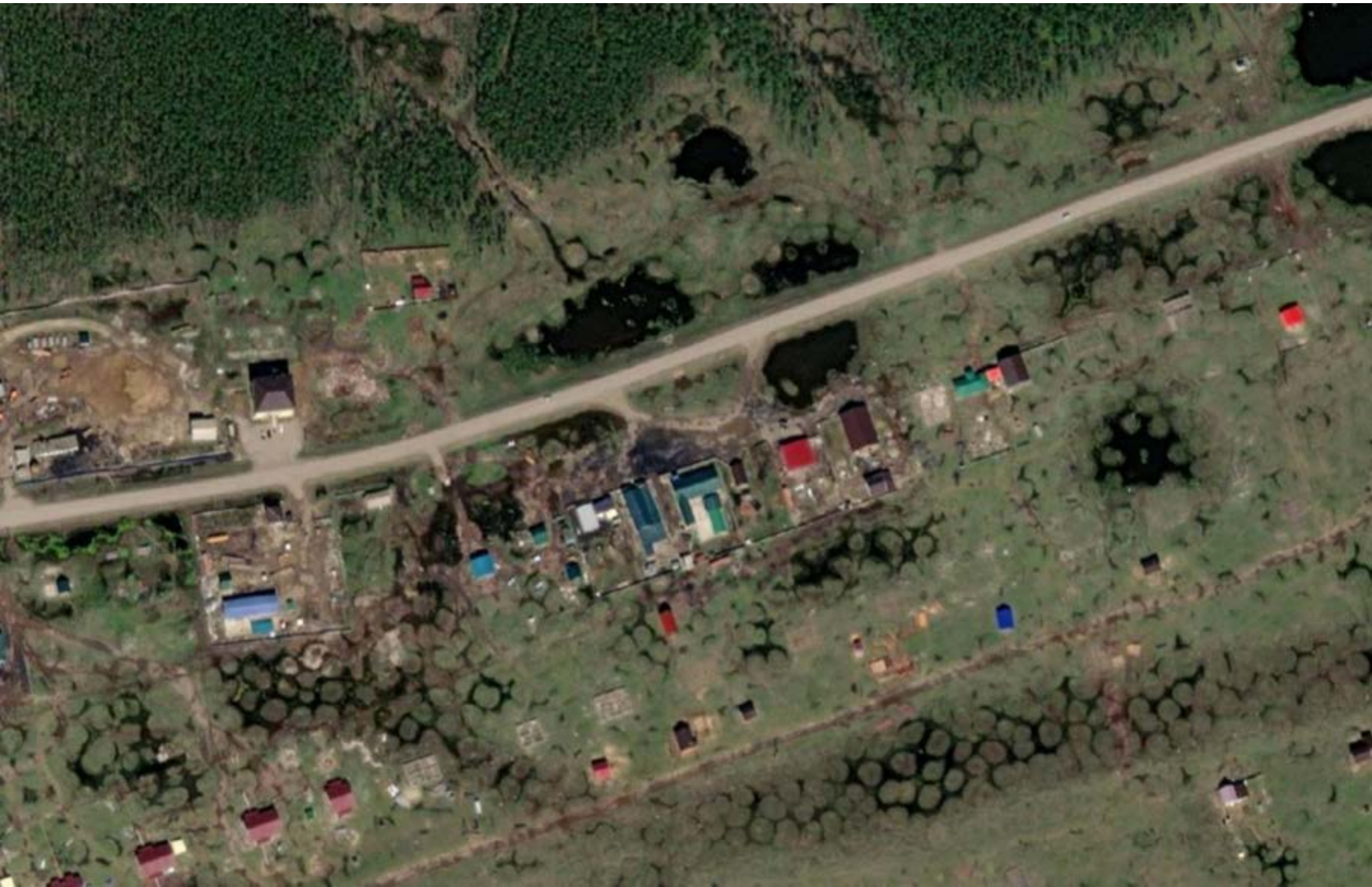
Инвентаризация опасностей



ВНИМАНИЕ

ЗОНА АКТИВНЫХ МЕРЗЛОТНЫХ ДЕФОРМАЦИЙ.
ПРОВОДЯТСЯ НАУЧНО-ИССЛЕДОВАТЕЛЬСКИЕ РАБОТЫ.
УЧАСТОК ПРОТЯЖЕННОСТЬЮ 200 м.
СРОКИ ПРОВЕДЕНИЯ РАБОТ:
III КВАРТАЛ 2020 г. – IV КВАРТАЛ 2021 г.
СОБЛЮДАЙТЕ СКОРОСТНОЙ РЕЖИМ

Road from Nadym to Salekhard

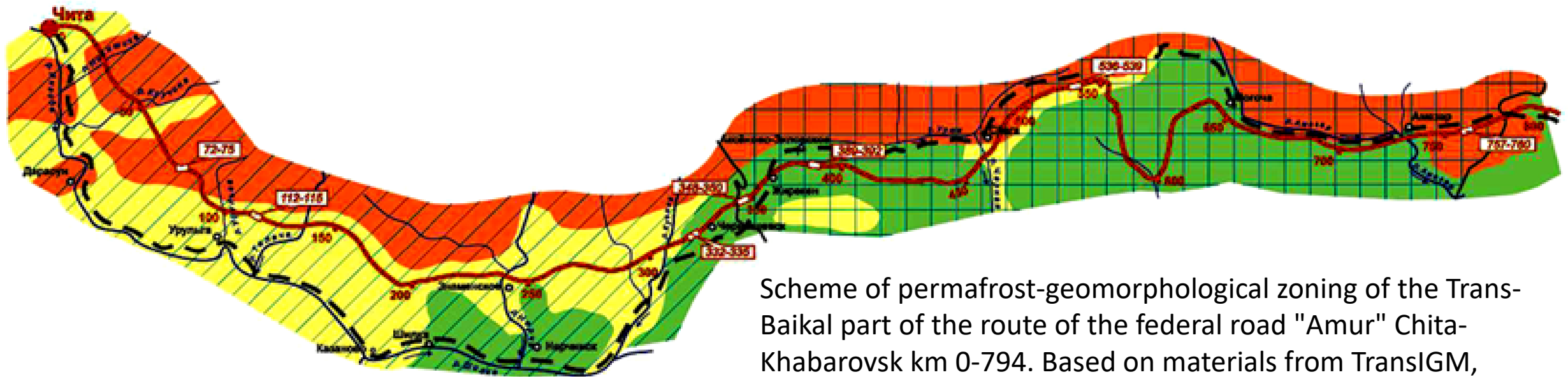


Ice wedge
thermokarst
near
Churapcha

*Photo from
Yakutsk
permafrost
Institute*

Remote methods are very helpful in diagnosing processes and zoning the lane adjacent to the road.



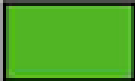




Scheme of permafrost-geomorphological zoning of the Trans-Baikal part of the route of the federal road "Amur" Chita-Khabarovsk km 0-794. Based on materials from TransIGM, 2004-2008, Soboleva S.V.


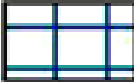

УСЛОВНЫЕ ОБОЗНАЧЕНИЯ

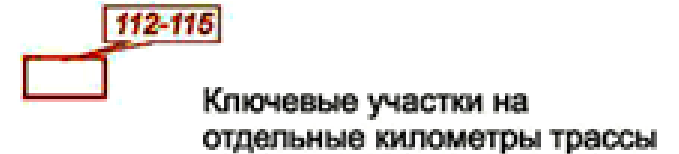
Geomorphological Regions

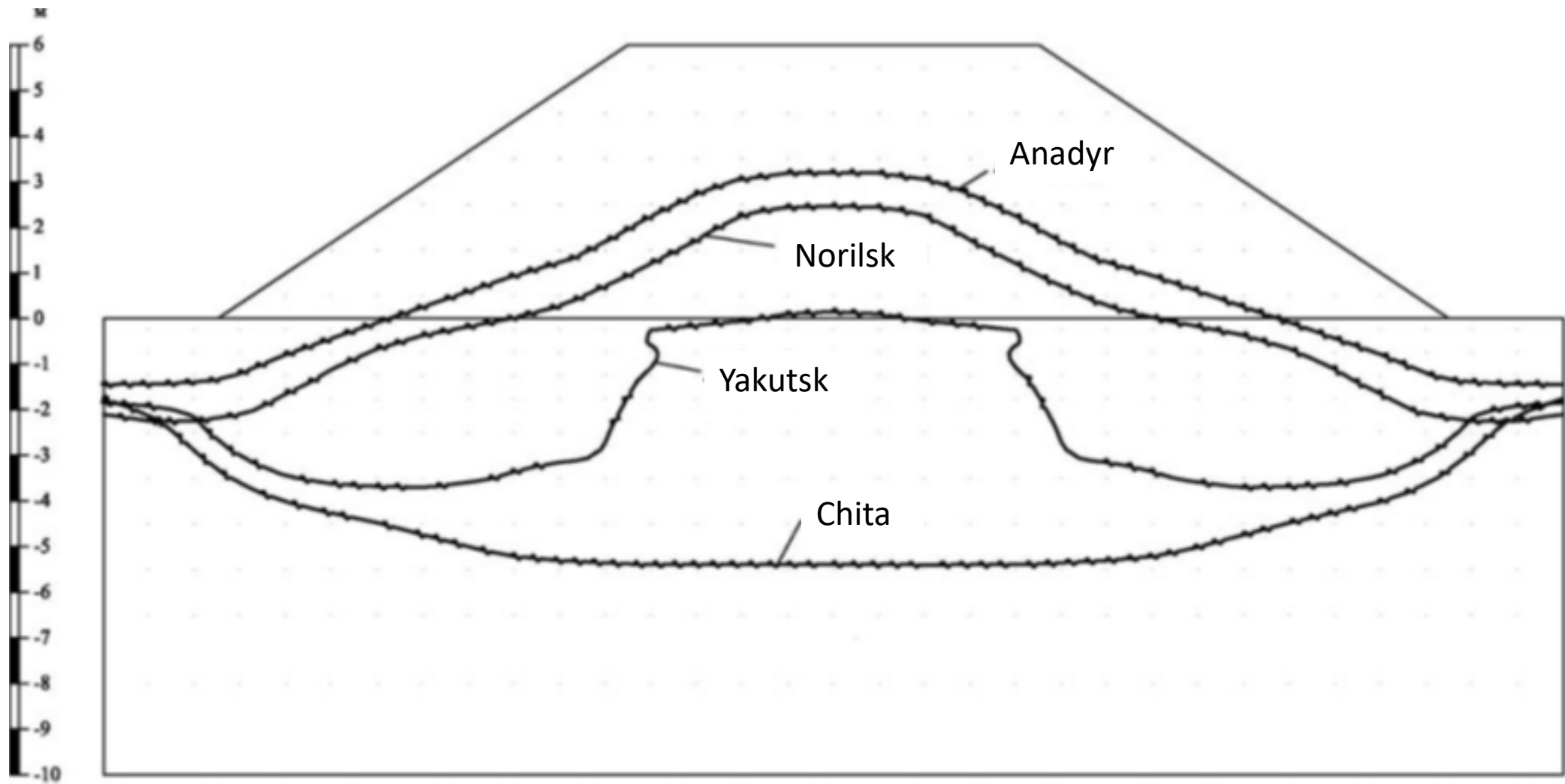
-  Даурское сводовое поднятие
-  Восточно-Забайкальская депрессия
-  Пришилкинская горно-долинная страна



Permafrost zones

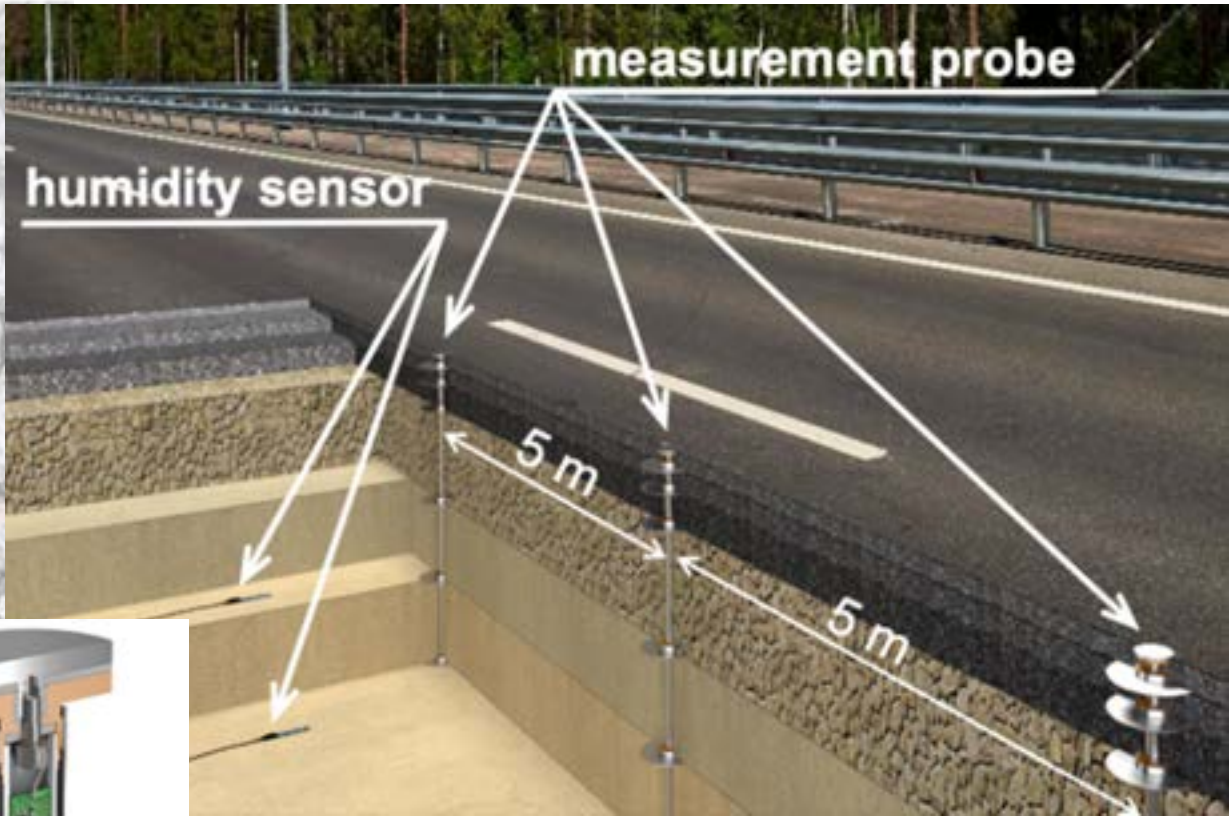
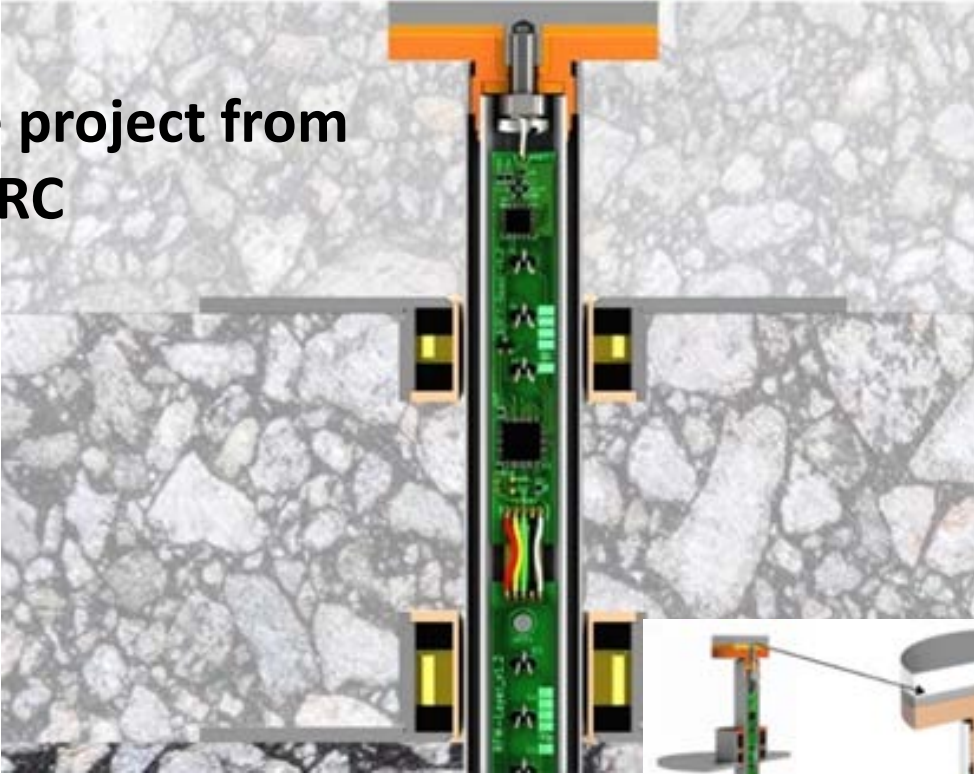
-  Зона несплошного распространения вечной мерзлоты с островами таликов
-  Зона сплошного распространения вечной мерзлоты
-  Условная граница между мерзлотными зонами





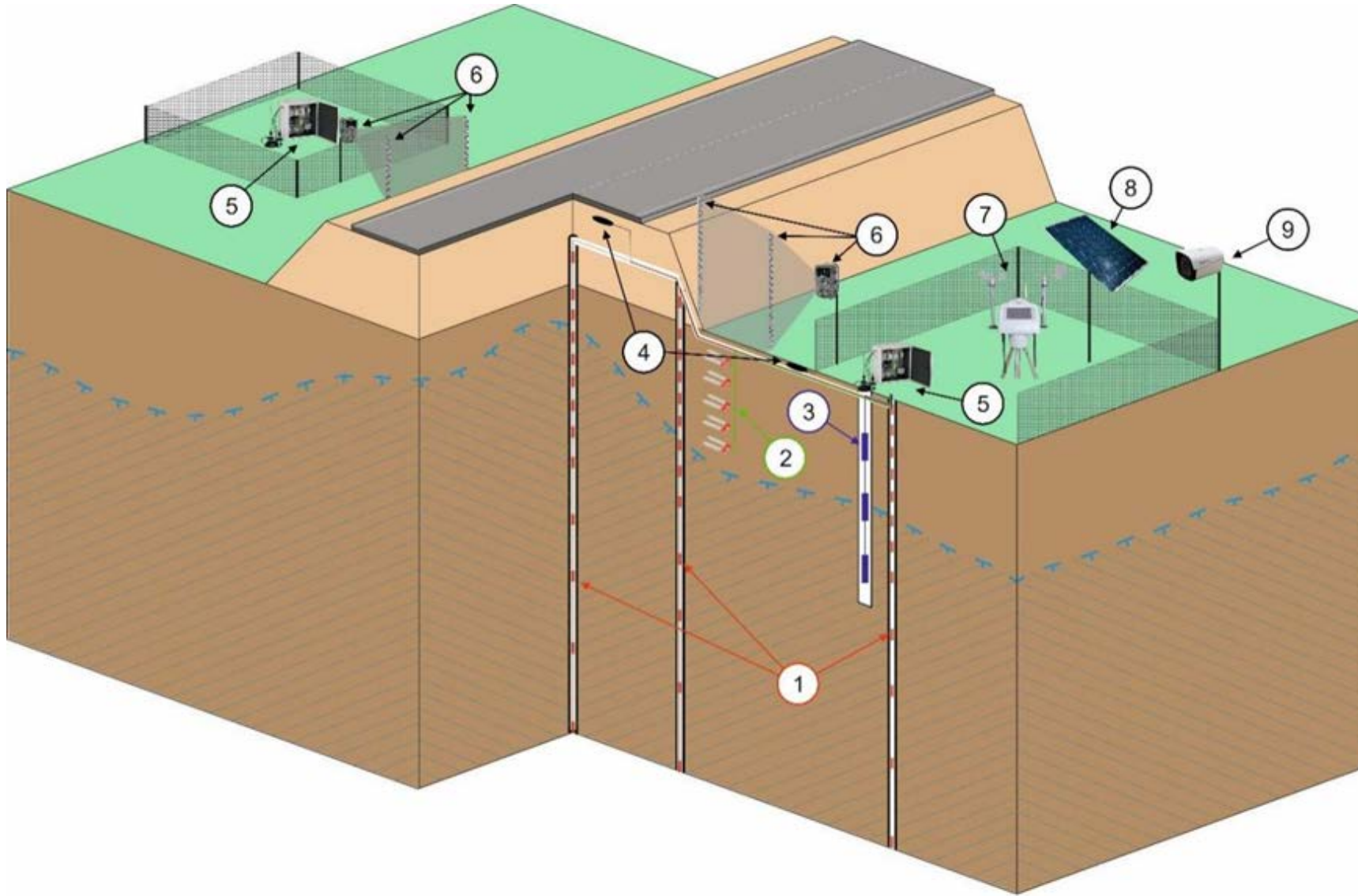
The position of the permafrost table under the embankment within the quasi-stationary state of the temperature field in various regions [Isakov, 2016]

The project from
PIARC



Location of pressure, deformation and humidity sensors in the road structure.

The project from Yakutsk Permafrost Institute



Legend:

I – asphalt concrete pavement of the road;
II – road embankment; III - soil-vegetative
layer of the roadside; IV - soil; V -
permafrost table; VI - permafrost;

1 - thermometric wells equipped with
thermal chains; 2 – soil moisture sensors;
3 – hydrogeological well equipped with
piezometric sensors; 4 – heat flux sensors;
5 – data acquisition module; 6 - snow
gauges and a camera trap for fixing the
height of snow; 7 - stationary
meteorological station; 8 - solar panel for
powering equipment; 9 - surveillance
camera.

