Assessments of potential damages in monetary terms from dangerous and adverse meteorological events (DE and AME) on the territory of the Russian Federation

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The variety of methods for assessing damages from hazardous and unfavorable hydrometeorological phenomena (OH and OH) often leads to incomparability of results

Especially for monetary estimates !!

Munich RE:

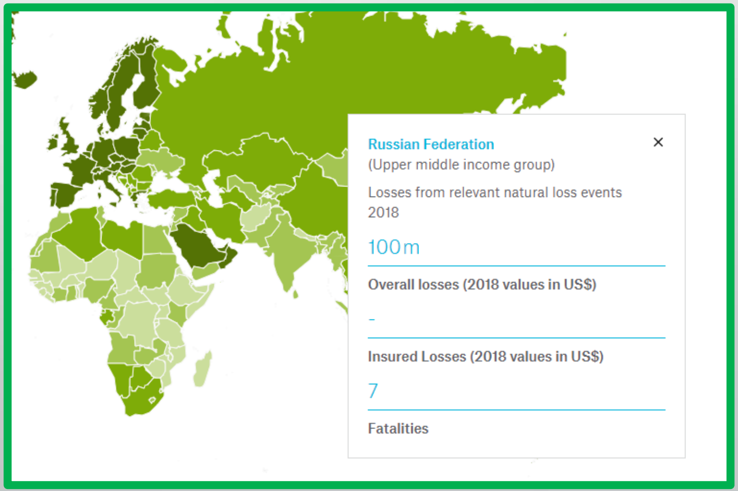
- for the period from 1980 to 2016, 16,584 natural hazards took place on the globe,
- 80% of them were related to the number of meteorological or hydrological phenomena
- the cumulative damage from these phenomena for the period under review amounted to about USD 4.3 trillion
- Natural Catastrophe Online Tool (http://natcatservice.munichre.com/)

Large scatter of estimates – they differ essentially, for example:

damage from Hurricane Katrina (2005) was: 82 (Knabb, RD, et al., 2005) 125 (Munich Re Group Annual Report 2012) and 150 (Burton, ML, Michael, JH, 2005) billion USD

- Estimates of actual and potential losses are the first step towards obtaining estimates of the economic effect of hydrometeorological services in monetary terms
- Roshydromet has at least 40 different methods for assessing the economic effect of hydrometeorological services

Munich RE on Russia in 2018:



Methods and techniques for assessing the risks of hazardous hydrometeorological phenomena and unfavorable weather conditions

Methodology for centralized assessment of averted losses for sectors of the economy

The information was provided by:

- the Ministry of Emergency Situations,
- the World Bank,
- participants of the project "Modernization and technical re-equipment of institutions and organizations of Roshydromet" (project "Roshydromet 1")
- data from the meteorological archives of the Hydrometeorological Center of Russia

And INFORMATION FROM RIHMI-WDC (for centralized assessment) !

The methodology considers the potential damage from a hydrometeorological phenomenon as an upper bound for the characteristic "averted losses"

The methodology assumes that, starting from a certain boundary value of each considered meteorological parameter (wind speed, precipitation amount, temperature, etc.) , there is a statistical relationship between potential damage in monetary terms from the corresponding phenomenon, and the magnitude of this phenomenon

And this statistical relationship - is linear. This relationship is determined by the regression model

Basic Information on the Regression Model

k - index, type of one of the considered phenomena;
i - is an index that determines the sector of the economy
j - is the index of the time characteristic (in this case, the year),
r - index indicating the territorial affiliation of the point where the phenomenon occurred.
Sr- characteristic of the vulnerability of the territory for the point r, where the phenomenon k occurred, taking into account the population density and the level of development of the economy and social infrastructure of the Subject of the Russian Federation.
Fj - inflation rate adjustment for a specific year

Potential damage in monetary terms caused simultaneously by a phenomenon of a given type for some industry, year, at a separate observation point located in the territory r:

$$\widehat{\mathbf{D}}_{\mathbf{ijkr}} = \mathbf{F_j} * \mathbf{S_r} * \boldsymbol{\theta}_{\mathbf{ik}}$$

- $$\boldsymbol{\theta}_{\mathbf{ik}} = \begin{cases} \boldsymbol{\alpha}_{\mathbf{ik}} + \boldsymbol{\beta}_{\mathbf{ik}}\mathbf{X_k}, & \text{если } \mathbf{X_k} \in \widetilde{\mathbf{X}}_{\mathbf{k}} \\ \mathbf{0}, & \text{если } \mathbf{X_k} \neg\in \widetilde{\mathbf{X}}_{\mathbf{k}} \end{cases}$$

X_k- Value of meteorological characteristic k, is a predictor

$$\mathrm{D}_{\mathrm{ijkr}} = \hat{\mathrm{D}}_{\mathrm{ijkr}} / \mathrm{m}_{\mathrm{r}}$$

$$\mathrm{D}^{\mathrm{R}}_{\mathrm{ijk}} = \sum_{r \in R} \mathrm{D}_{\mathrm{ijkr}}$$

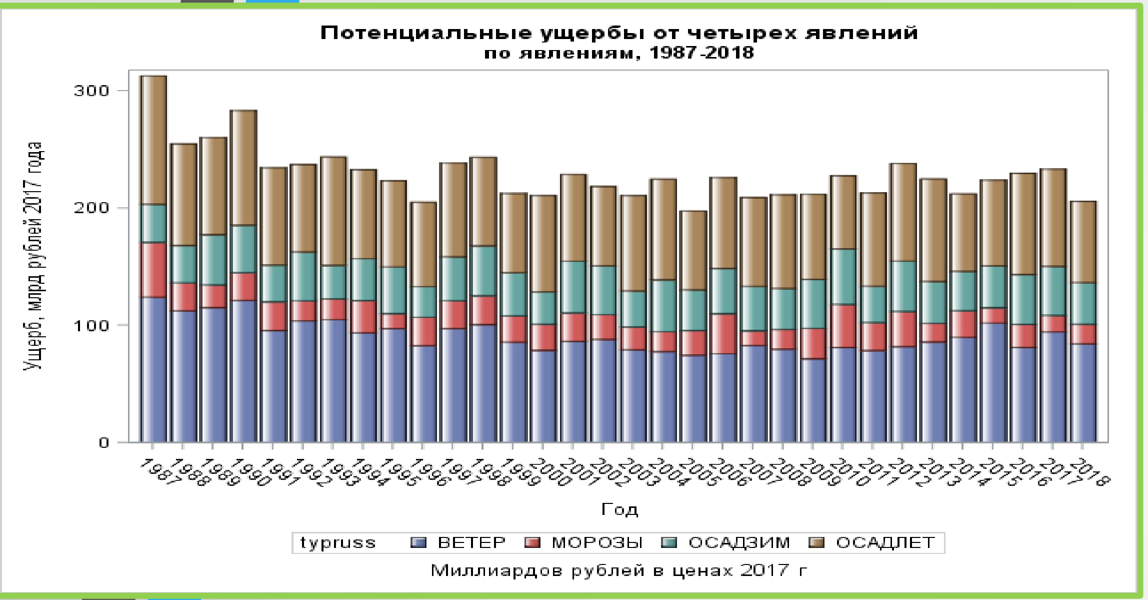
R – set of points at some territory where the phenomenon was observed

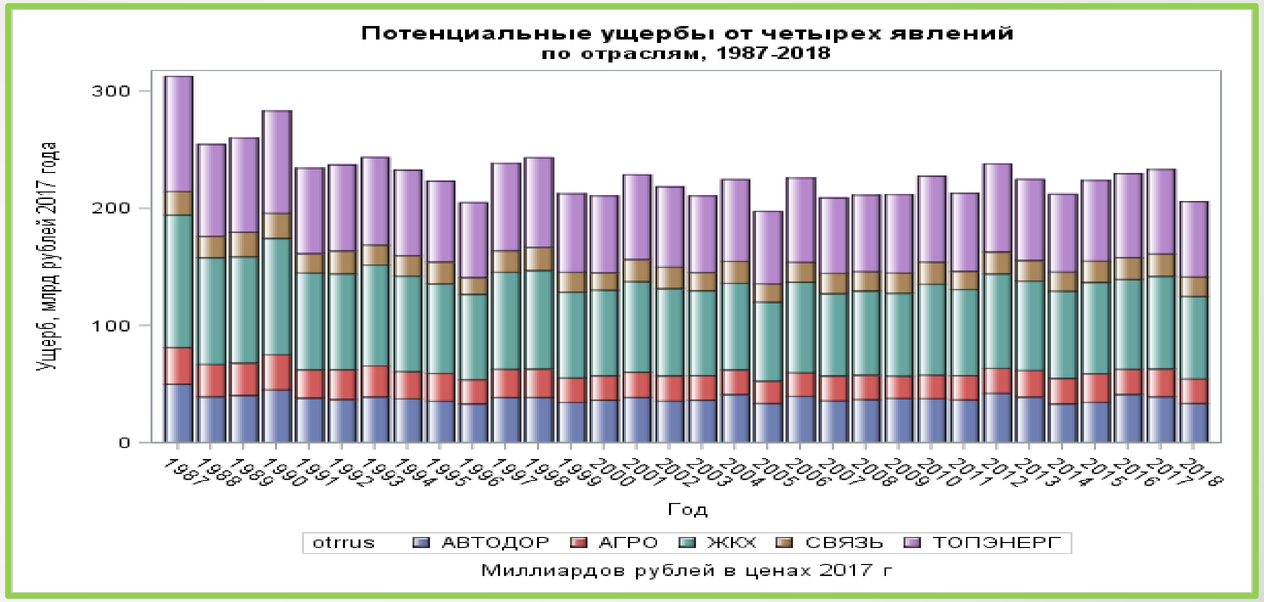
- Estimates for 1987-2018 based on daily data from the TMSS array
- A dataset of daily data was used, containing more than 25 million observations at approximately 1460 stations in the territory of the Russian Federation.
- Regression model parameters: specific coefficients for combinations of each phenomenon and each industry
- Representation of summarized potential damages (in rubles) by:
  - Phenomena
  - Years
  - Industries
  - Territories of Federal districts
  - Territories of Subjects of the Federation
  - Territories of various UGMS (Roshydromet Administrations)

Potential damages from DE and AME for 4 phenomena and 5 sectors, obtained on the basis of a centralized method, for 1987 - 2018, in billion rubles at the level of 2017

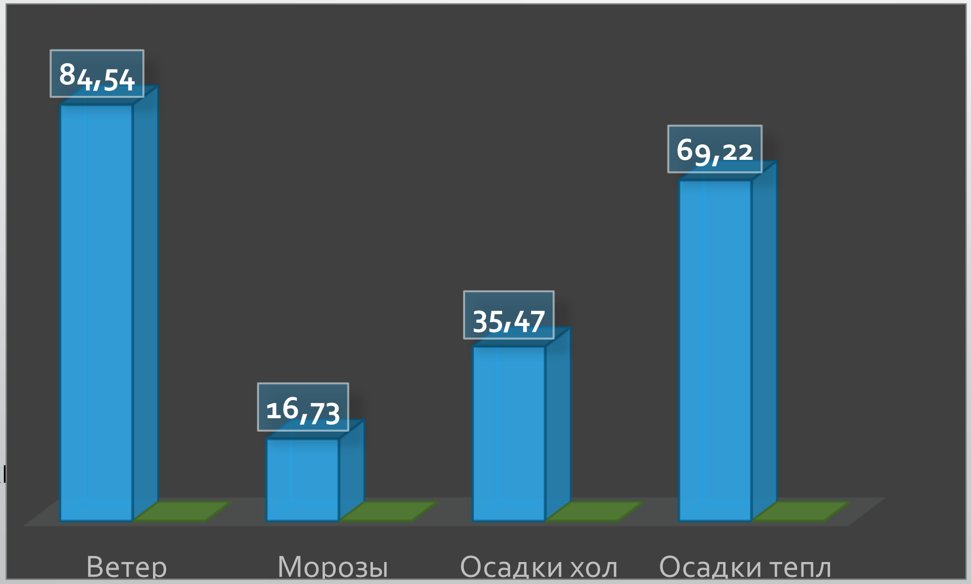
	ВЕТЕР					МОРОЗЫ				ОСАДЗИМ						ОСАДЛЕТ						
	АГРО	ЖКХ	СВЯЗЬ	ТОПЭНЕРГ	ИТОГО:	АВТОДОР	ЖКХ	ТОПЭНЕРГ	ИТОГО:	АВТОДОР	АГРО	ЖКХ	СВЯЗЬ	ТОПЭНЕРГ	ИТОГО:	АВТОДОР	АГРО	ЖКХ	СВЯЗЬ	ТОПЭНЕРГ	ИТОГО:	ИТОГО:
1987	23,30	54,98	9,23	36,71	124,22	7,28	20,66	19,06	47,00	8,80	0,38	4,41	7,49	11,08	32,15	34,05	7,60	33,26	3,24	31,60	109,76	313,13
1988	21,22	49,88	8,34	33,15	112,59	3,79	10,52	9,71	24,03	8,82	0,37	4,30	7,37	10,97	31,83	26,88	5,95	26,37	2,61	25,02	86,83	255,28
1989	21,71	51,10	8,56	34,03	115,41	3,09	8,46	7,81	19,37	11,73	0,50	5,87	9,97	14,74	42,81	25,68	5,68	25,19	2,50	23,95	83,00	260,58
1990	22,77	53,82	9,04	36,00	121,63	3,72	10,34	9,55	23,61	11,21	0,47	5,50	9,42	13,98	40,58	30,33	6,76	29,65	2,90	28,17	97,81	283,63
1991	18,09	42,45	7,08	28,15	95,77	3,87	10,79	9,96	24,62	8,65	0,36	4,23	7,25	10,78	31,28	25,74	5,73	25,16	2,46	23,93	83,02	234,70
1992	19,55	46,09	7,71	30,73	104,07	2,76	7,46	6,89	17,11	11,32	0,49	5,75	9,71	14,32	41,59	23,20	5,18	22,65	2,21	21,55	74,79	237,57
1993	19,64	46,55	7,83	31,26	105,27	2,81	7,72	7,13	17,66	7,94	0,33	3,84	6,60	9,80	28,51	28,65	6,38	28,06	2,76	26,60	92,44	243,89
1994	17,54	41,54	6,97	27,86	93,91	4,31	12,08	11,15	27,54	9,84	0,42	4,87	8,31	12,29	35,73	23,60	5,28	23,00	2,23	21,91	76,02	233,19
1995	18,16	43,13	7,26	29,02	97,57	2,02	5,52	5,09	12,63	10,87	0,47	5,49	9,29	13,72	39,85	22,83	5,07	22,36	2,20	21,26	73,72	223,78
1996	15,53	36,70	6,15	24,54	82,91	3,78	10,70	9,87	24,34	7,16	0,31	3,55	6,05	8,99	26,05	22,34	4,99	21,79	2,12	20,72	71,96	205,26
1997	18,11	43,13	7,26	29,10	97,61	3,70	10,37	9,57	23,64	10,29	0,44	5,12	8,71	12,89	37,46	24,85	5,54	24,31	2,38	23,05	80,14	238,85
1998	18,61	44,52	7,52	30,19	100,84	3,88	10,84	10,01	24,73	11,58	0,50	5,89	9,94	14,62	42,54	23,42	5,22	22,92	2,25	21,75	75,54	243,65
1999	15,88	37,90	6,39	25,64	85,82	3,55	9,90	9,14	22,59	10,18	0,42	5,02	8,56	12,65	36,83	20,89	4,61	20,52	2,04	19,49	67,56	212,79
2000	14,70	34,87	5,85	23,42	78,85	3,48	9,86	9,10	22,44	7,71	0,31	3,71	6,38	9,47	27,58	25,42	5,64	24,92	2,46	23,66	82,10	210,97
2001	15,97	38,24	6,46	25,97	86,64	3,74	10,70	9,87	24,31	12,21	0,50	6,04	10,28	15,12	44,16	22,93	5,12	22,41	2,19	21,26	73,91	229,01
2002	16,29	38,88	6,56	26,31	88,04	3,34	9,38	8,65	21,37	11,41	0,48	5,73	9,70	14,30	41,62	21,01	4,65	20,60	2,04	19,59	67,88	218,91
2003	14,83	35,13	5,89	23,55	79,41	3,06	8,54	7,88	19,49	8,29	0,37	4,26	7,17	10,58	30,66	25,22	5,60	24,71	2,44	23,45	81,42	210,98
2004	14,54	34,47	5,78	23,13	77,93	2,67	7,42	6,84	16,93	12,08	0,52	6,10	10,32	15,19	44,21	26,64	5,92	26,10	2,57	24,78	86,01	225,08
2005	14,00	33,09	5,54	22,14	74,77	3,26	9,23	8,52	21,01	9,59	0,41	4,76	8,11	12,01	34,88	20,85	4,64	20,37	1,99	19,38	67,23	197,89
2006	14,21	33,67	5,64	22,58	76,11	5,23	14,97	13,81	34,01	10,45	0,46	5,37	9,04	13,32	38,64	24,10	5,37	23,56	2,31	22,40	77,72	226,48
2007	15,50	36,76	6,17	24,68	83,11	1,97	5,42	5,00	12,39	10,37	0,45	5,23	8,85	13,05	37,95	23,56	5,23	23,06	2,27	21,93	76,05	209,50
2008	14,91	35,37	5,93	23,76	79,97	2,62	7,38	6,81	16,80	9,62	0,41	4,73	8,08	11,99	34,82	24,87	5,54	24,33	2,38	23,10	80,23	211,83
2009	13,40	31,70	5,30	21,21	71,61	4,07	11,53	10,64	26,24	11,41	0,49	5,75	9,73	14,33	41,71	22,50	5,01	22,01	2,16	20,90	72,58	212,14
2010	15,15	35,95	6,04	24,16	81,30	5,65	16,23	14,97	36,86	12,84	0,56	6,56	11,05	16,26	47,28	19,37	4,30	18,94	1,86	18,04	62,50	227,94
2011	14,71	34,82	5,84	23,33	78,71	3,69	10,46	9,65	23,80	8,59	0,36	4,22	7,21	10,68	31,05	24,64	5,46	24,17	2,39	22,94	79,60	213,16
2012	15,34	36,32	6,09	24,33	82,08	4,59	13,13	12,11	29,82	11,79	0,51	5,98	10,10	14,88	43,26	25,75	5,71	25,25	2,49	23,99	83,19	238,35
2013	16,07	38,04	6,38	25,49	85,99	2,52	7,03	6,48	16,03	9,72	0,43	4,95	8,36	12,34	35,80	27,05	6,01	26,54	2,62	25,16	87,39	225,21
2014	16,83	39,83	6,68	26,68	90,01	3,54	9,97	9,20	22,70	9,18	0,39	4,61	7,81	11,54	33,54	20,54	4,57	20,07	1,96	19,09	66,24	212,48
2015	18,97	45,17	7,61	30,46	102,20	2,07	5,70	5,26	13,03	9,82	0,42	4,90	8,32	12,29	35,75	22,79	5,09	22,26	2,17	21,15	73,45	224,43
2016	15,09	35,96	6,04	24,28	81,37	3,08	8,69	8,01	19,78	11,65	0,49	5,83	9,87	14,51	42,35	26,72	5,91	26,28	2,62	24,90	86,42	229,92
2017	17,56	41,86	7,04	28,26	94,72	2,20	6,20	5,72	14,11	11,46	0,48	5,68	9,67	14,26	41,55	25,84	5,75	25,30	2,49	23,99	83,37	233,75
2018	15,63	37,34	6,29	25,28	84,54	2,58	7,36	6,79	16,74	9,65	0,42	4,91	8,29	12,20	35,46	21,47	4,80	20,99	2,05	19,91	69,22	205,96

Potential damages from DE and AME for 4 phenomena and 5 sectors, obtained on the basis of a centralized method, for 1987 - 2018, in billion rubles at the level of 2017



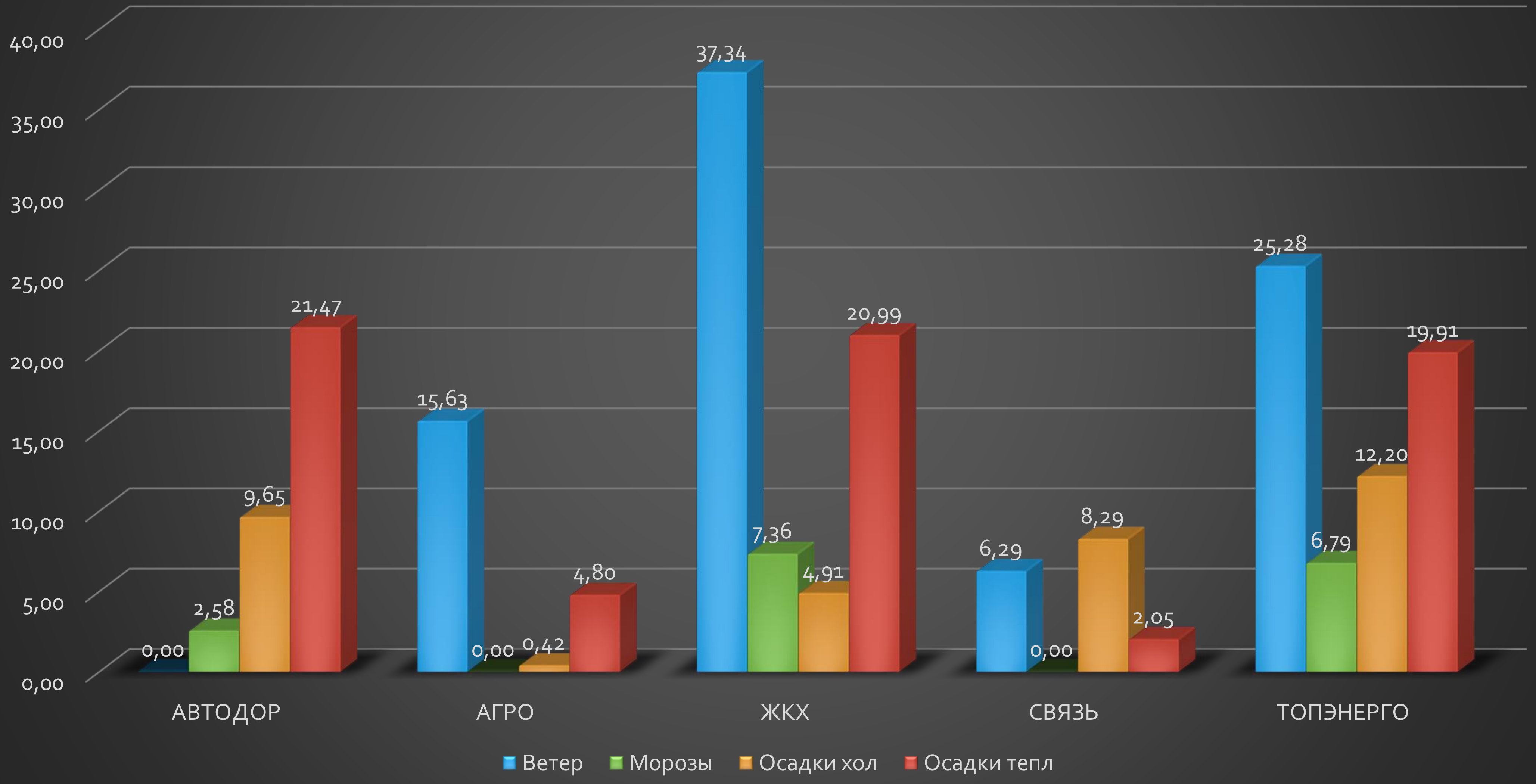


2018 demonstrates one of the lowest estimate of potential damage for 4 events.
Total for 4 events for 5 industries: 205.96 billion rubles

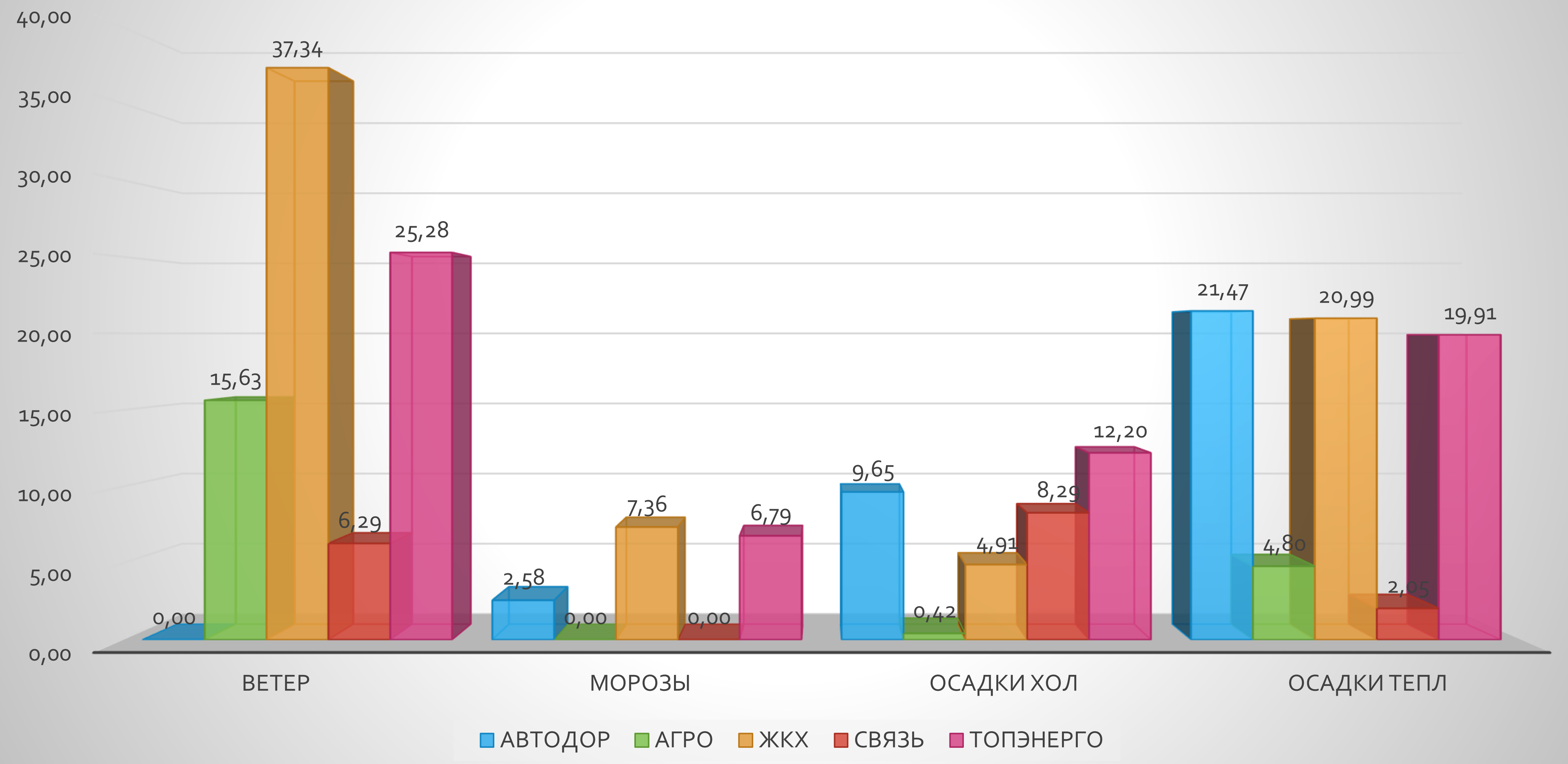


Lower than in 2018 - only in 1996 (205.26 billion rubles) and in 2005 (197.89 billion rubles at the level of 2017)

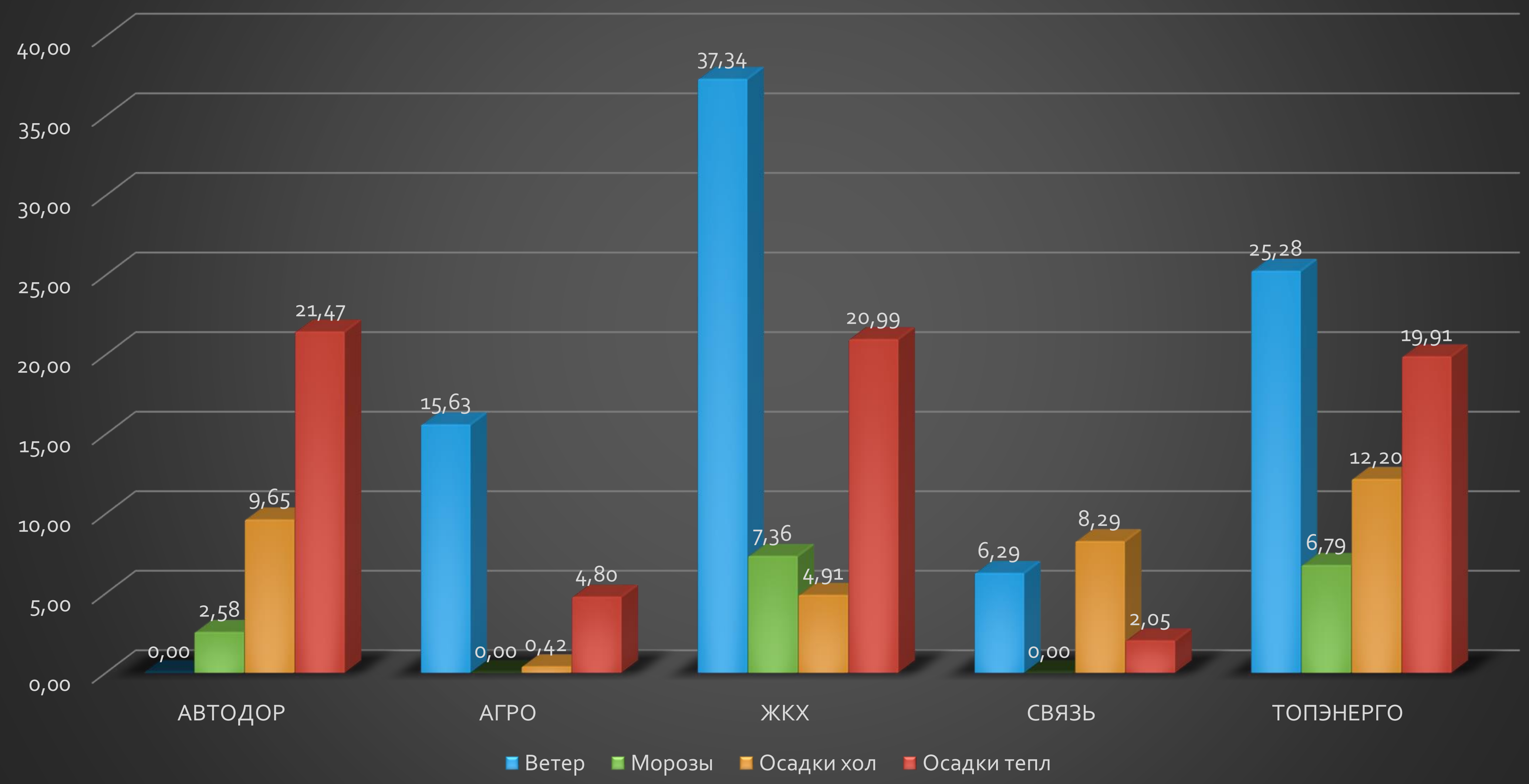
Потенциальные ущербы от четырех явлений, 2018 год, млрд. рублей уровня 2017 г



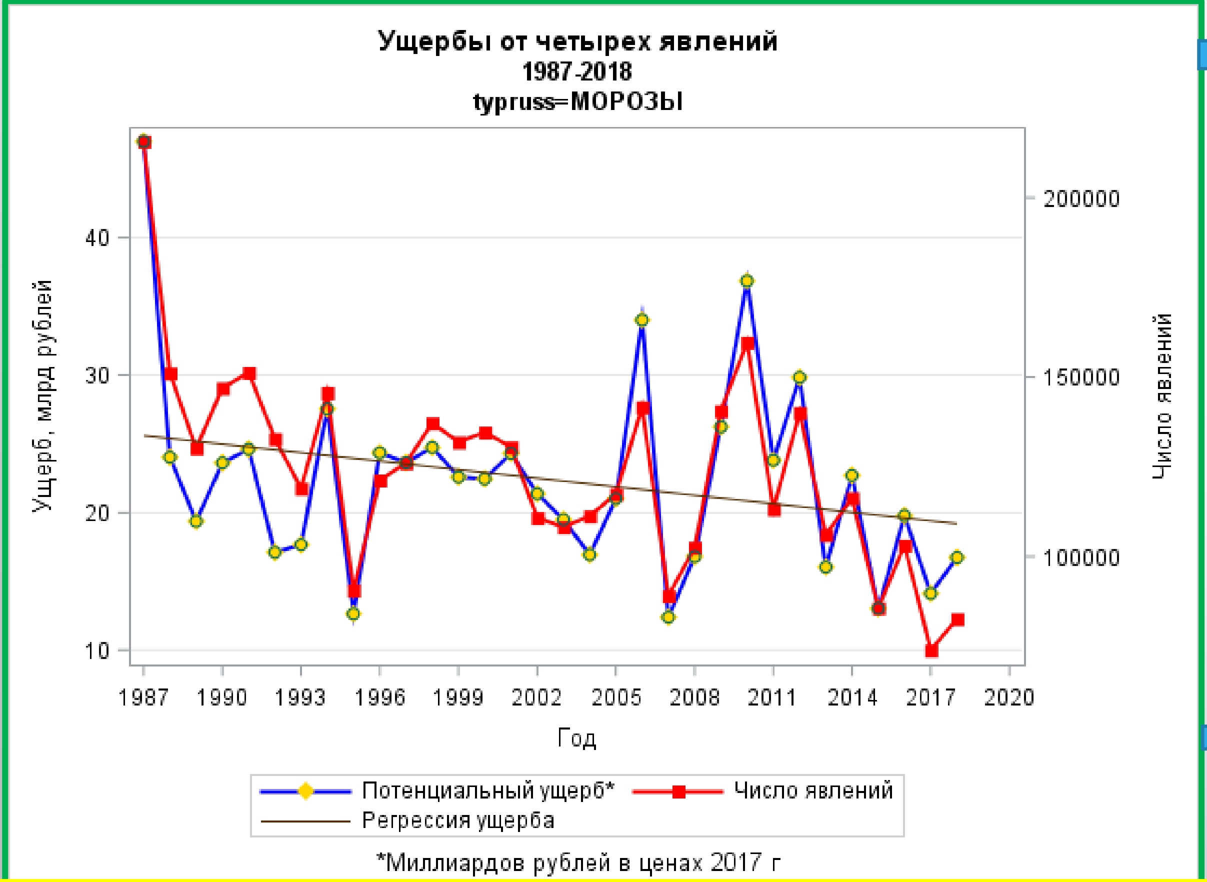
Потенциальные ущербы от четырех явлений, 2018 год, млрд. руб уровня 2017 г

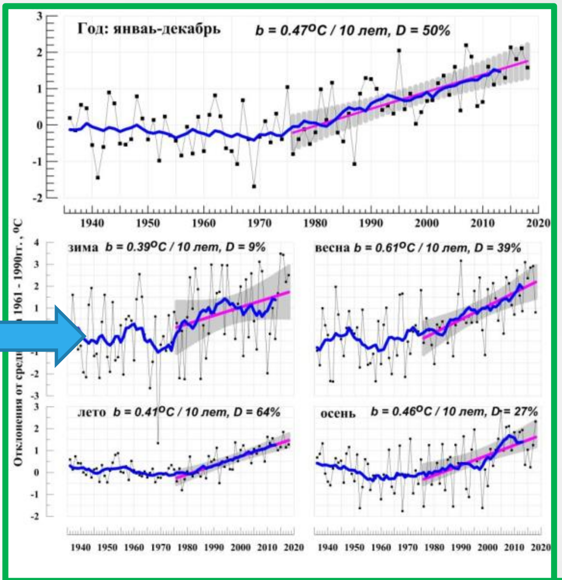


Потенциальные ущербы от четырех явлений, 2018 год, млрд. рублей уровня 2017 г

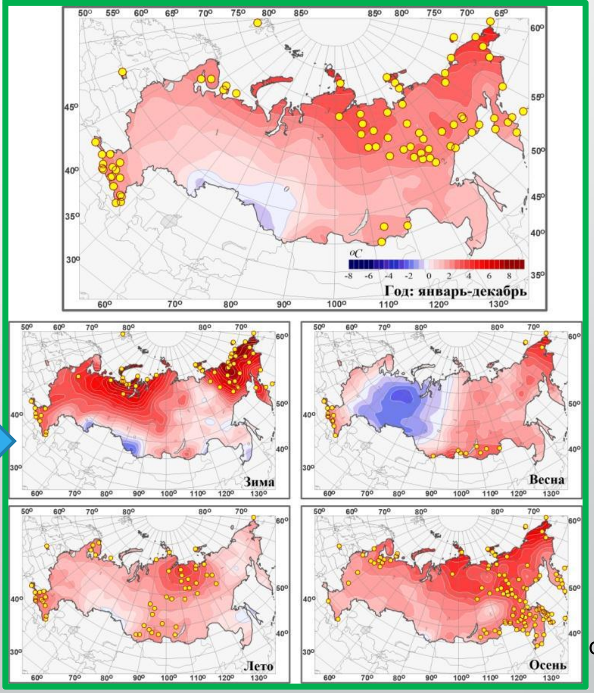


POTENTIAL DAMAGES CAUSED BY: SEVERE FROSTS



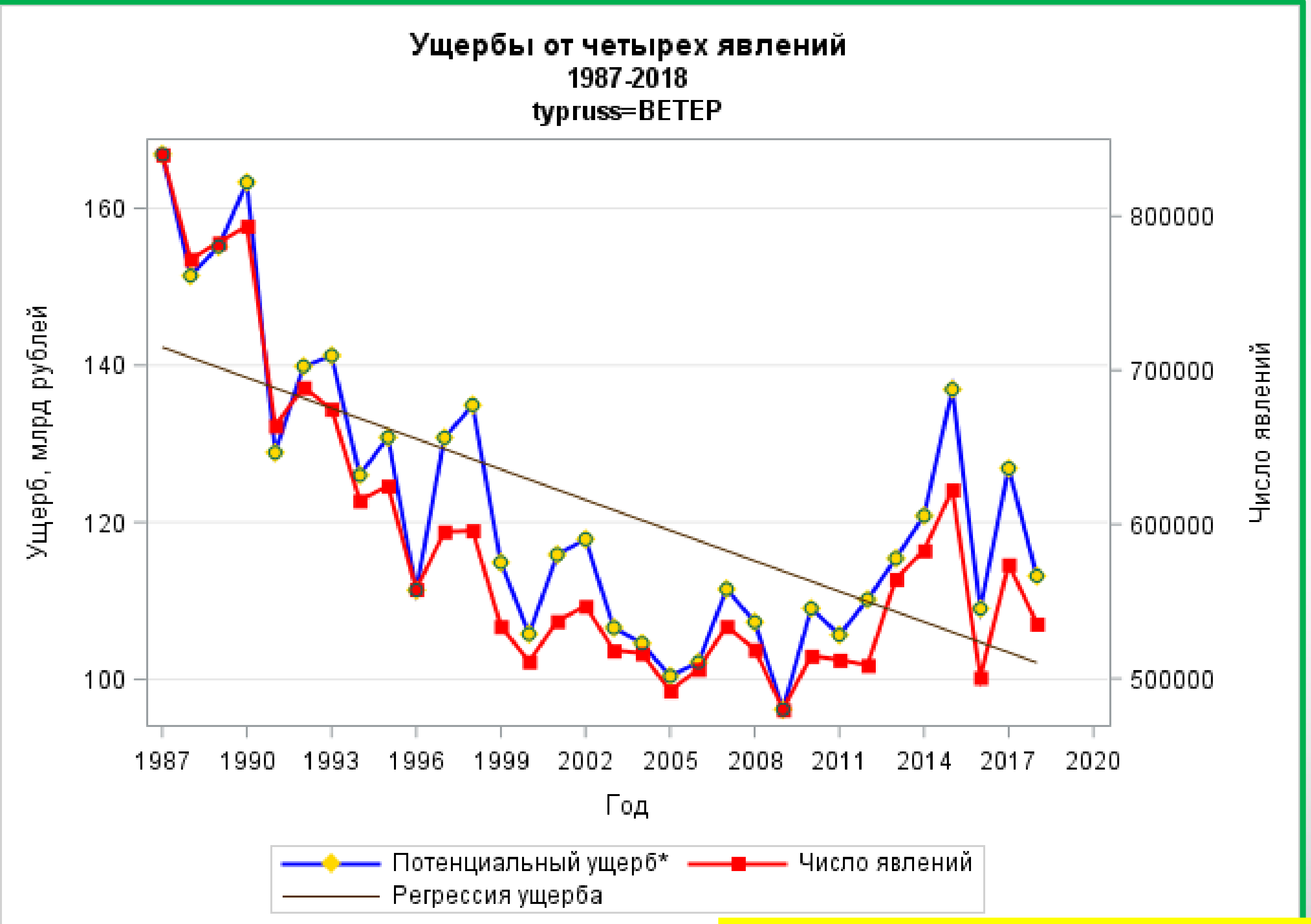


ANOMALIES OF 2018

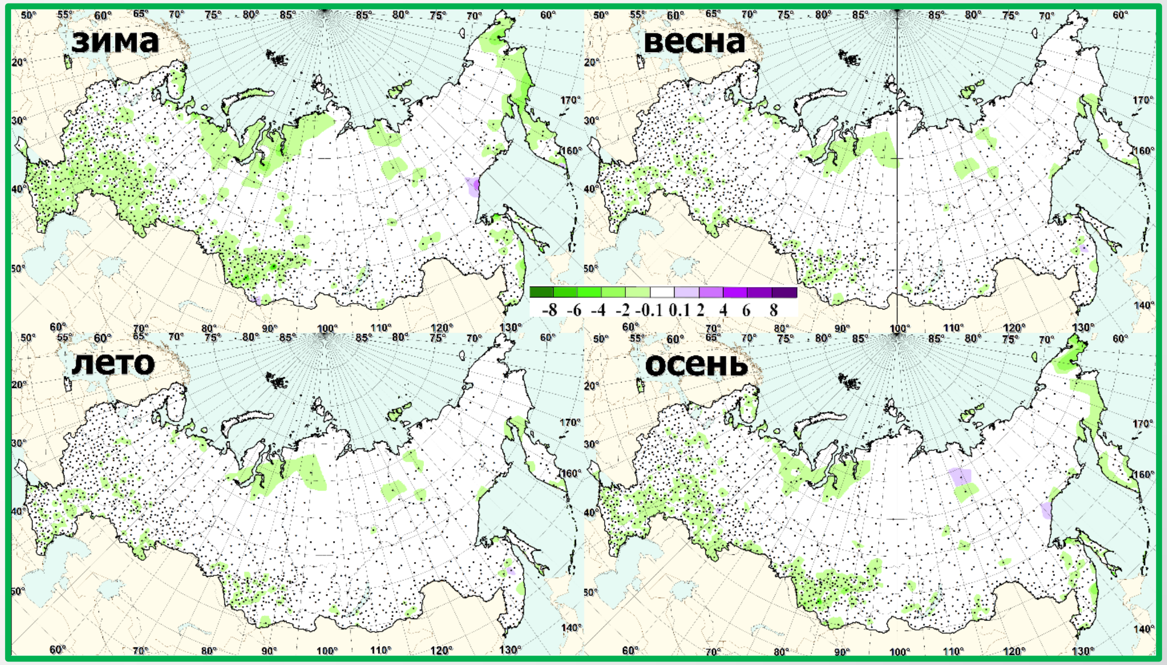


Из «Доклада об особенностях климата на территории Российской Федерации за 2018 год» (Москва, 2019, 78 стр. – М., Росгидромет2019, ISBN 978-5-906099-58-7

POTENTIAL DAMAGES CAUSED BY:
STRONG WINDS & GUSTS OF WIND



*Миллиардов рублей в це



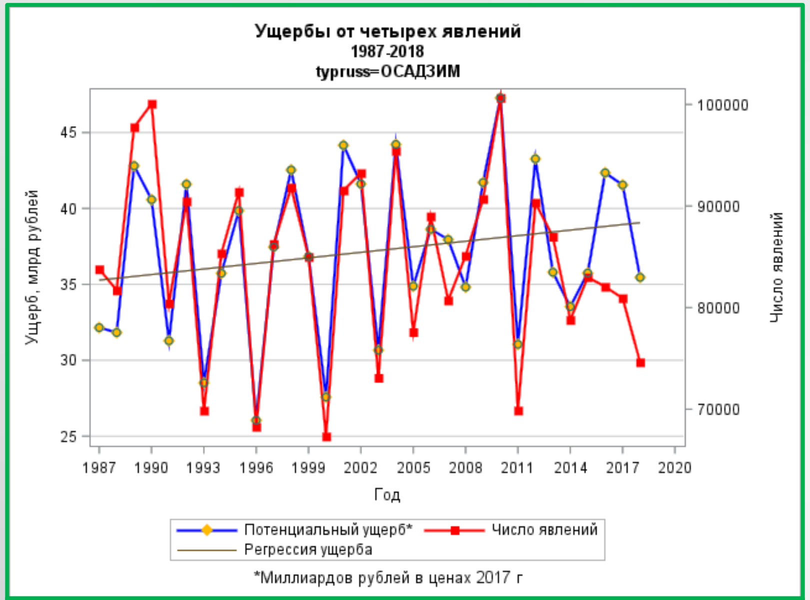
- Коэффициенты линейного тренда (день/10лет) в рядах числа дней со скоростью больше 15 м/с (статистически значимые на 5%-ом уровне значимости). 1976-2018гг

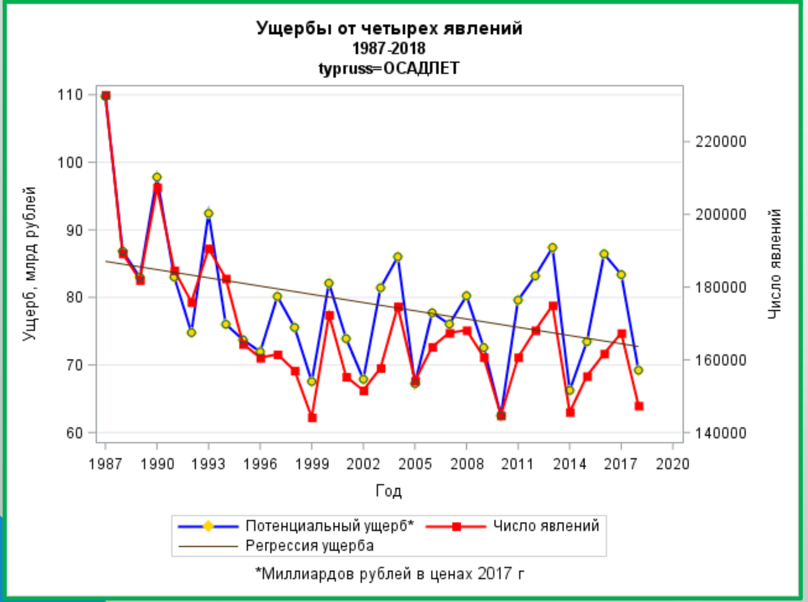
Из «Доклада об особенностях климата на территории Российской Федерации за 2018 год» (Москва, 2019, 78 стр. – М., Росгидромет2019, ISBN 978-5-906099-58-7

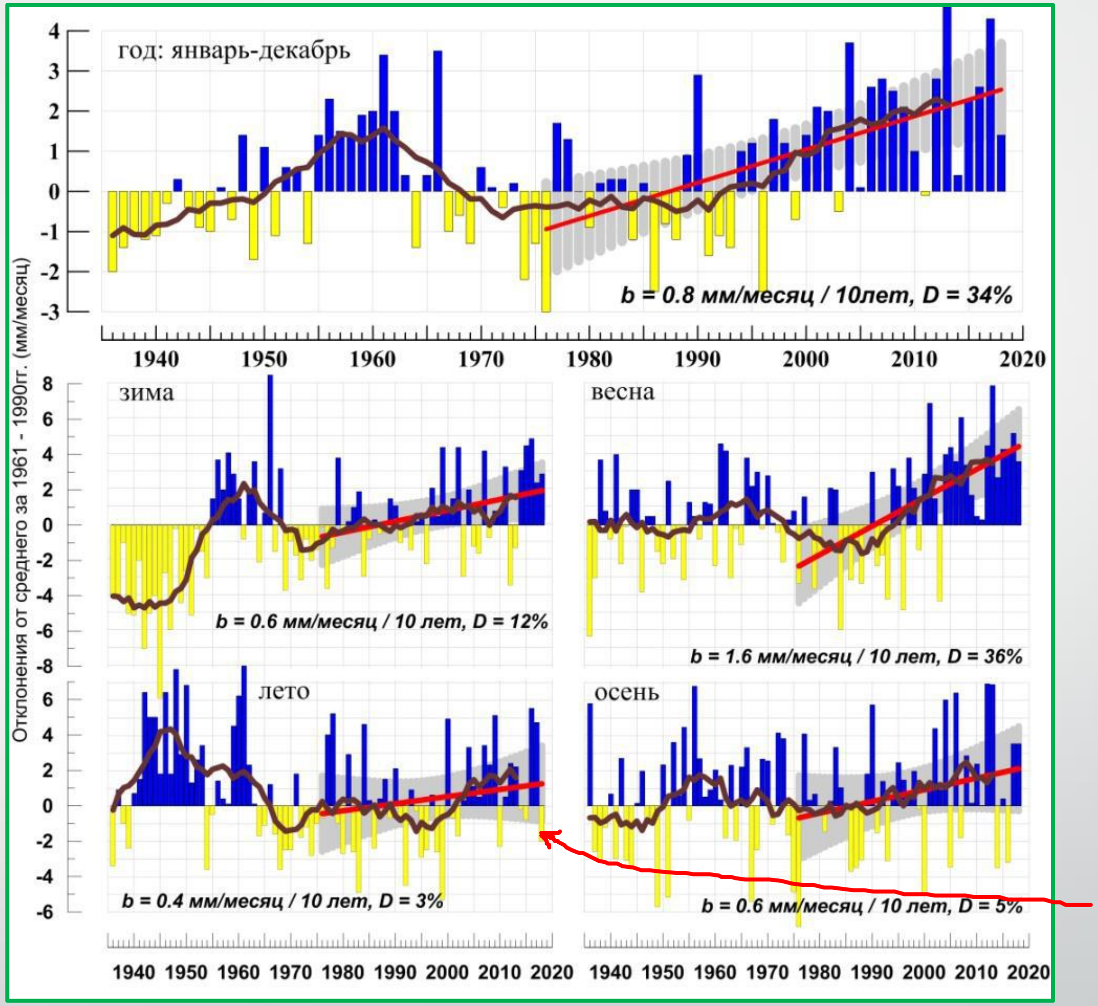
In winter and in autumn, the number of days with a wind speed of more than 15 m / s decreases essentially in regions with the most developed economies

POTENTIAL DAMAGES CAUSED BY:

COLD PERIOD PRECIPITATION (TOP)
WARM PERIOD PRECIPITATION (BOTTOM)







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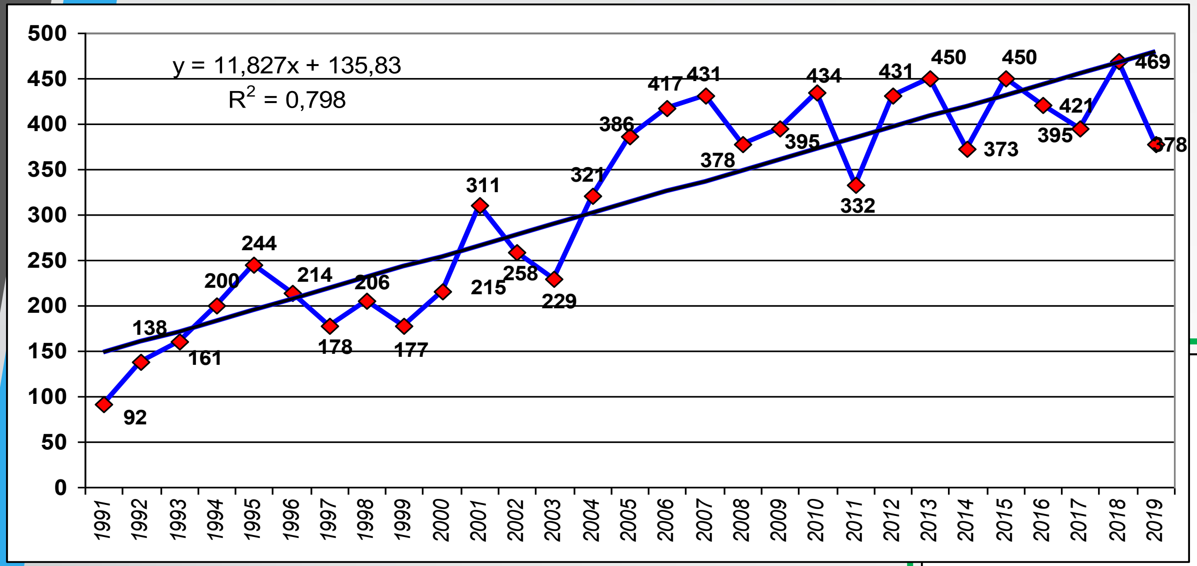
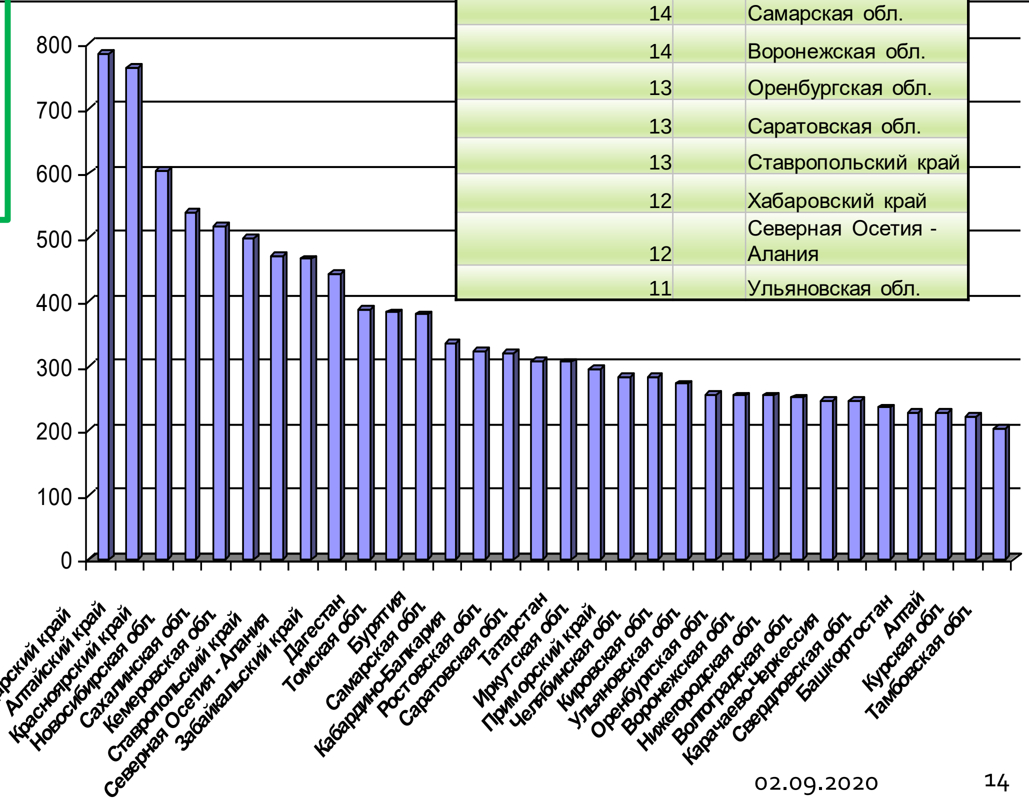
DYNAMICS OF dangerous and adverse meteorological events with a registered damage



За 2019 год:

36	Краснодарский край
27	Бурятия
27	Крым
25	Алтайский край
23	Красноярский край
22	Приморский край
21	Иркутская обл.
16	Новосибирская обл.
15	Томская обл.
14	Волгоградская обл.
14	Самарская обл.
14	Воронежская обл.
13	Оренбургская обл.
13	Саратовская обл.
13	Ставропольский край
12	Хабаровский край
12	Северная Осетия - Алания
11	Ульяновская обл.



Macroeconomic estimates vs centralized model

- This model includes a number of simplifying assumptions. This should be taken into account when obtaining results!
- This model does not consider hydrological events!!
- Macroeconomic estimates (World Bank, Munich Re 2014, B.N. Porfiriev -2015, 2019):
- The share of damage from natural disasters of climatic and hydrometeorological origin is 0.5-0.6% of GDP for countries with a level of economic development similar to Russia

- Russia's GDP in 2017: 92,089 billion rubles.
- 0.5 - 0.6% of GDP is about 460 to 553 billion rubles

- The share of damage from meteorological disasters is about 40% of the damage from all natural disasters, those. for 2017 within 185-221 billion rubles
- According to the calculations according to the centralized method,
- in 2017, damages amounted to approximately 233 billion rubles

From: Munich Re 2014

Concluding remarks

- This model includes a number of simplifying assumptions. This should be taken into account when obtaining results!
- Russia's GDP in 2017: 92,089 billion rubles. 0.3 - 0.4% of GDP is approximately from 276 - 368 billion rubles
- The main contribution to the integral assessments of potential damage in monetary terms is made by events at which the values of meteorological parameters still do not allow, according to official criteria, to be attributed to OY.
- At the same time, the individual contributions of such events to the damage are small, but their high frequency predetermines an essentially high contribution
- Further work should be aimed at expanding the list of phenomena for which models are being built, at specifying the numerical parameters of regression models for assessing monetary potential damage, at detailed estimates of the repeatability of various ranges of meteorological values and the corresponding contributions of these ranges to the final values of potential damage ... BUT!
- There is a fairly detailed picture of the weather and climatic situation, including extremes and values close to them.
- BUT!!!!! To have better models, we need reliable data on actual damages in monetary terms!
- Precipitation should be considered especially!
- Numerical data were used, which should be characterized as "Big Data". However, a huge layer of useful information contains unstructured data (summaries, text descriptions, information from social networks, etc.)

THANK YOU!