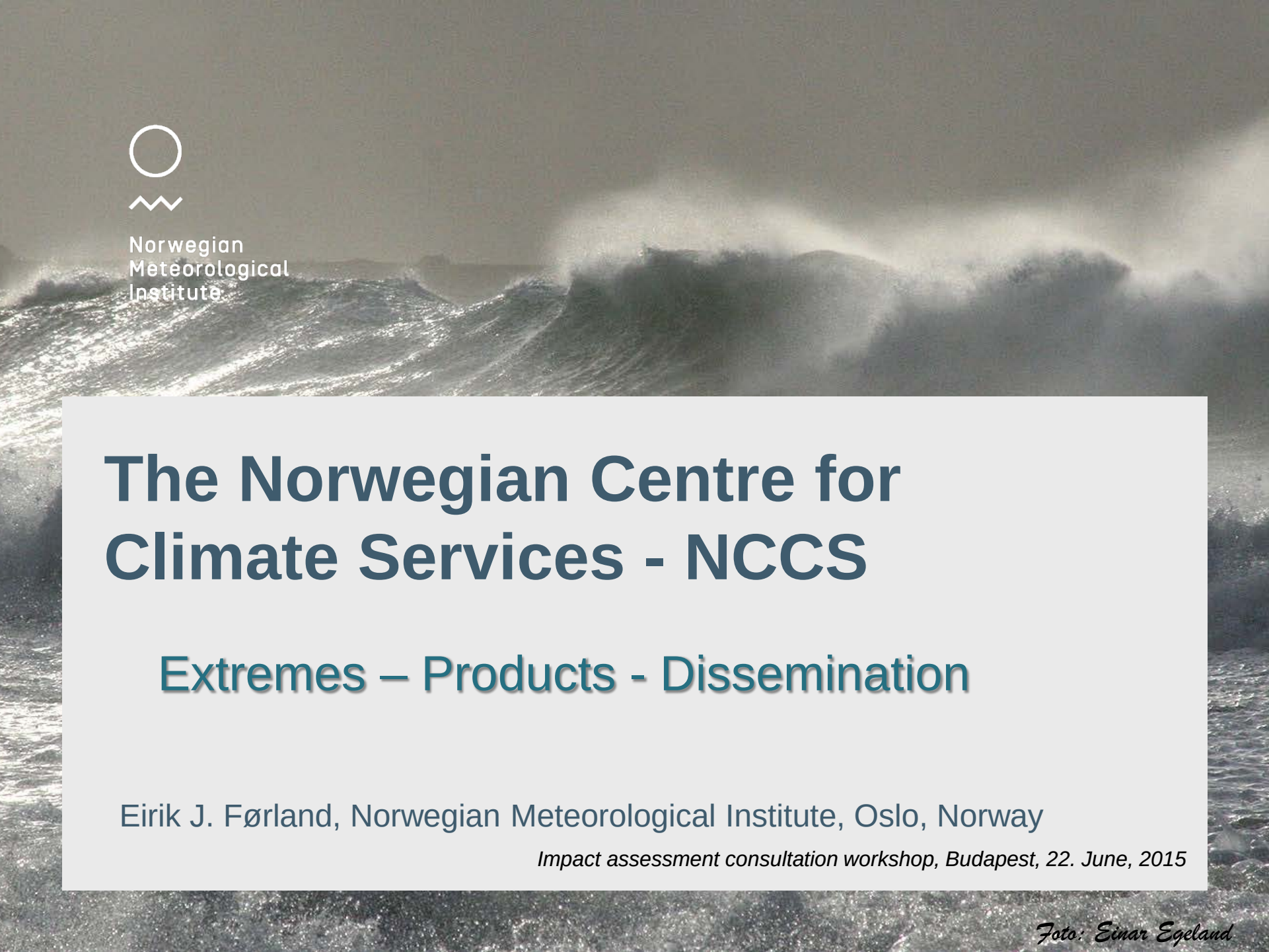


Norwegian Meteorological Institute

The Norwegian Centre for Climate Services - NCCS

Extremes – Products - Dissemination

Eirik J. Førland, Norwegian Meteorological Institute, Oslo, Norway

Impact assessment consultation workshop, Budapest, 22. June, 2015

Foto: Einar Egeland

KRIGiS: Vulnerability / Impact Studies with a focus on:

- Tourism
- Critical Infrastructures

TOURISM

Førland et al., 2012: ***Cool weather tourism under global warming: Comparing Arctic summer tourists' weather preferences with regional climate statistics and projections*****. Tourism Management, 2012**

CRITICAL INFRASTRUCTURES

Knowledge gap

Norwegian Meteorological Institute

What do the users need ???

- Variables/ indices ?
- Time horizon ?
- Scales (time and space) ?
- Uncertainty

Temperature?
Snow? Rain? Wind?
Freezing degree days?
Growing season?
Droughts?

20 yrs?
50 yrs? 100 yrs?
Regional values?
Local values?

Monthly?
Daily? Hourly?
Return periods?
Climatology?

“one number”?
“probability distribution”?
“high/low”?

Norwegian Center for Climate Services (NCCS): *Provide decision makers in Norway with information relevant for climate adaptation*

- User needs
- Extremes
  - Hot days
  - Heavy rainfall
- Products
  - General projections
  - Gridded maps
- Dissemination
  - Communication with users
  - “From science to services”

Norwegian Meteorological Institute

Norwegian Centre for Climate Services

- A cooperation between
  - **MET Norway**
  - **Norwegian Water Resources and energy Directorate**
  - **Uni Research (Bergen)**

- The **Norwegian Environment Agency** is represented in the board

Norwegian Meteorological Institute

- **We need to plan for future climate change**
- **… in some ways we are not even adapted to the present climate…**

Important user categories - 1:

- Governmental institutions and authorities:
  - National to municipality level
  - Roads, railways, coastal infrastructure etc.
- Sectors/Industries, e.g.:
  - Energy
  - Buildings
  - Health
  - Primary industries

Important user categories - 2:

Climate impact research

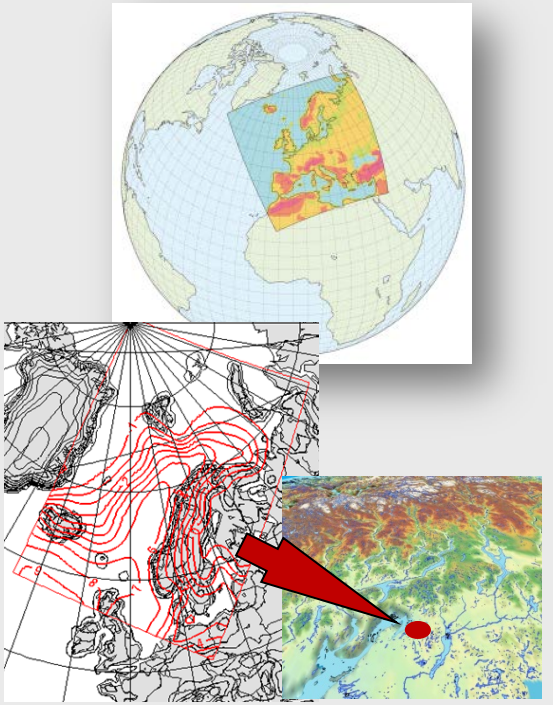
- Physical nature
- Ecosystems
- Society

Different users/different needs:

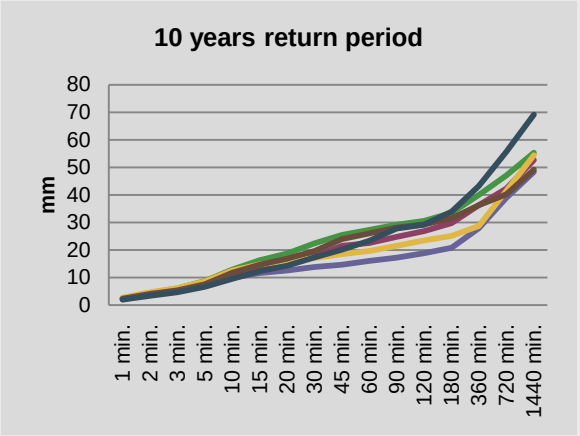
- The engineer needs “one number”: A design value to avoid this →
- The municipality planner needs a map showing how close to a river to allow e.g. dwelling areas
- The impact researcher may need detailed and consistent climate projections of a number of variables or indices…

Scales in space and time

- Spatial resolution:
  - Downscaling is important for most users
  - Applying both RCMs and ESDs is reassuring…

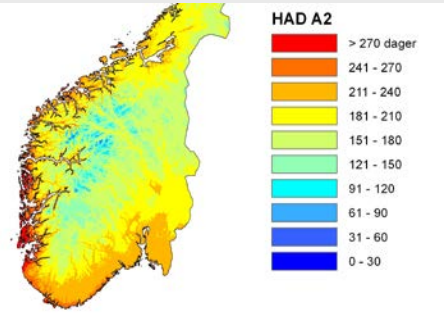


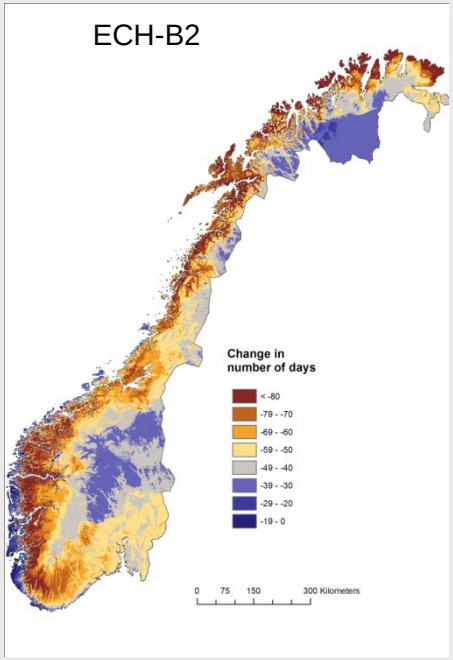
- Time resolution:
  - Global/regional models takes us down to hours, but minute values are used for calculating design values for precip.
  - Possible to take the last bit with empirical functions?



Bias adjustment

- Bias adjustment of climate projections is necessary for
  - Calculating indices like growing season, heating degree days etc.
  - Hydrological modelling, incl. snow conditions
- Bargains:
  - Reproducing “present climate” vs. keeping the “climate signal”
  - Taking care of the tails in the distribution vs. computer time

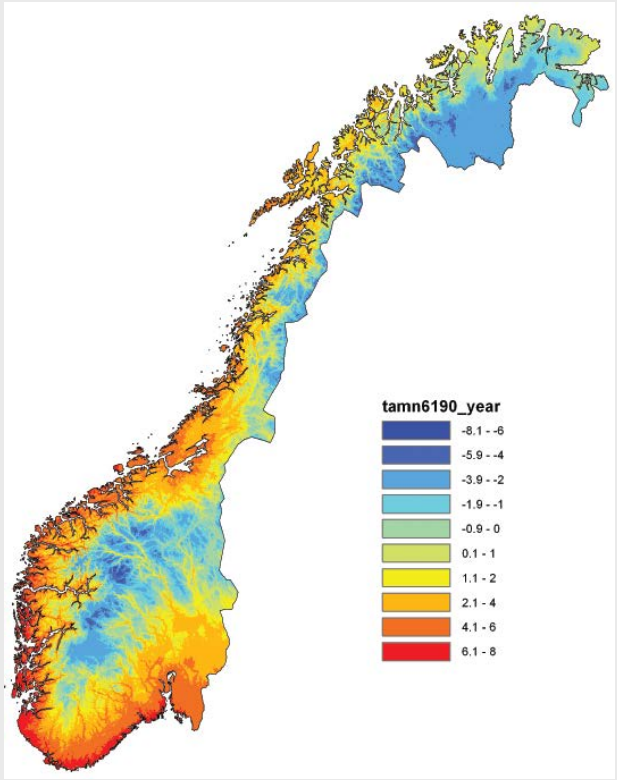




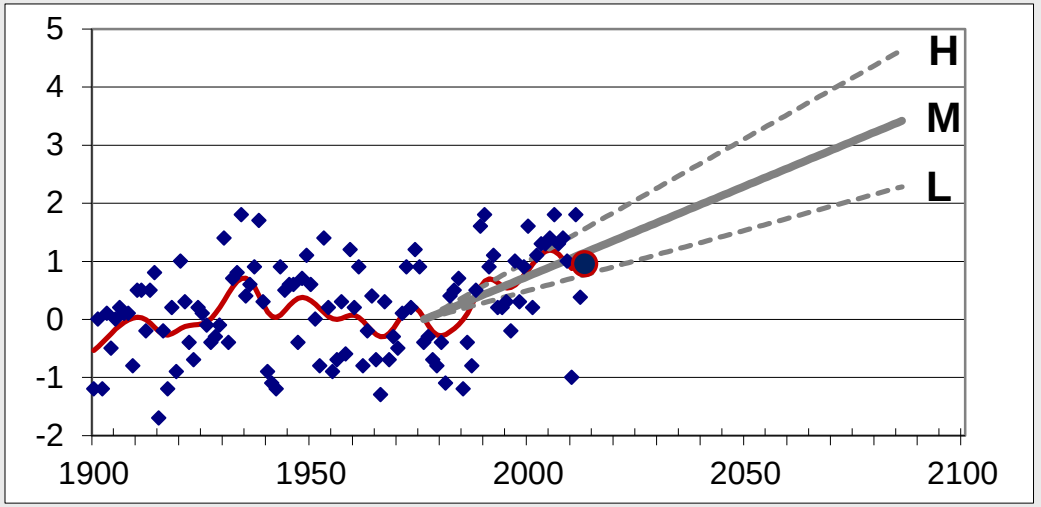
Examples of NCCS products

www.klimaservicesenter.no

General projections: Temperature



Annual temperature 1961-90 (degC)



Region	Sesong	Økning (°C) til 2021–50			Økning (°C) til 2071–2100		
		M	L	H	M	L	H
Norge	År	1,9	1,2	2,5	3,4	2,3	4,6
	Vinter DJF	2,3	1,5	3,3	4,3	2,8	6,0
	Vår MAM	1,9	1,2	2,6	3,5	2,3	4,8
	Sommer JJA	1,3	0,8	1,9	2,4	1,4	3,5
	Høst SON	1,9	1,3	2,6	3,5	2,4	4,8
TR-1 Østlandet	År	1,9	1,2	2,6	3,4	2,3	4,8
	Vinter DJF	2,4	1,5	3,5	4,5	2,8	6,5
	Vår MAM	1,7	1,1	2,5	3,2	1,9	4,6
	Sommer JJA	1,3	0,8	2,0	2,5	1,5	3,8
	Høst SON	1,9	1,3	2,8	3,6	2,5	5,1

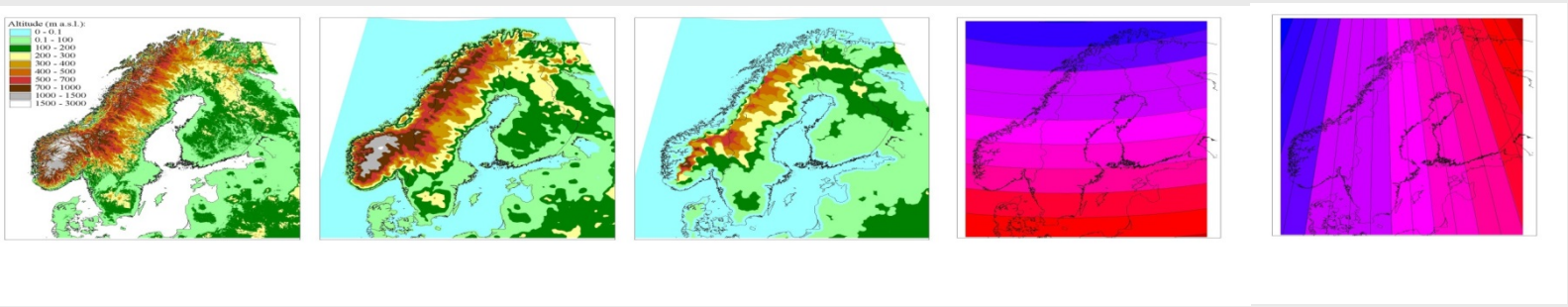
Klimagrid v1.1 Temperature

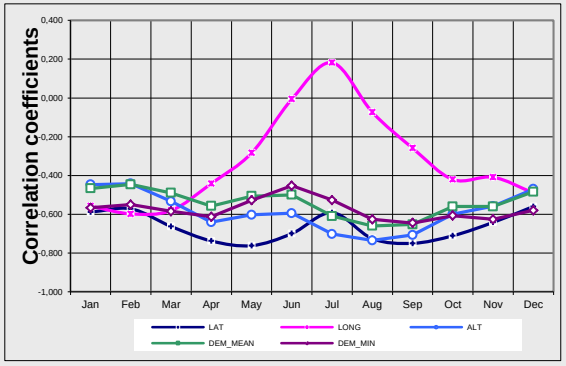
- Residual interpolation:

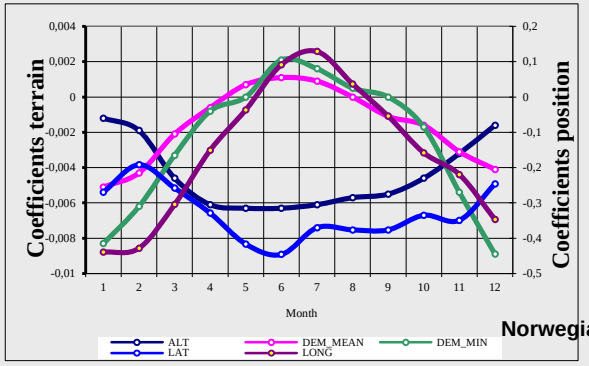
$$\hat{t}(u_0) = \sum_{i=1}^{n} \lambda_i t(u_i) + \{\alpha_0 + \alpha_1\beta_1(u_0) + \alpha_2\beta_2(u_0) + \ldots\ldots + \alpha_m\beta_m(u_0)\}$$

Kriging
(or any spatial interpolation method)

External trend/drift
(linear regression)

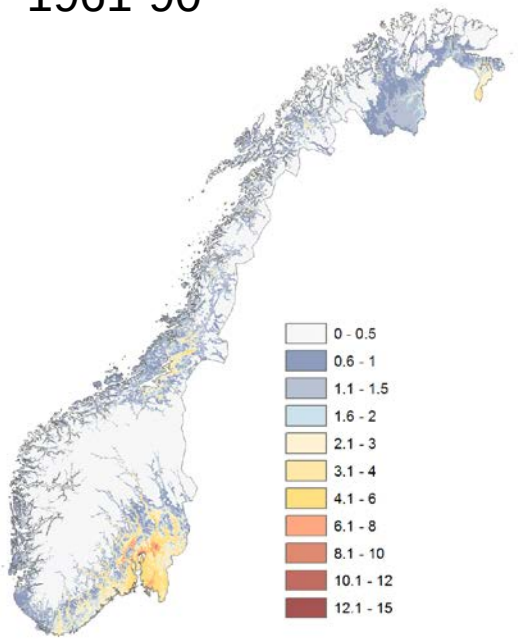




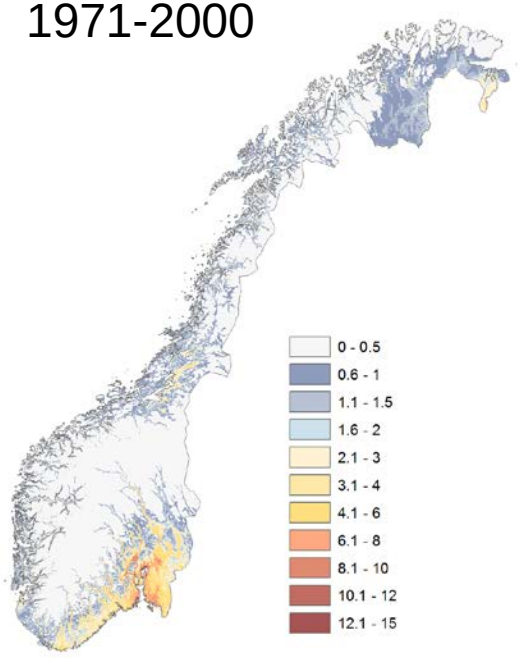


Number of «Warm days» T_{mean} >20C

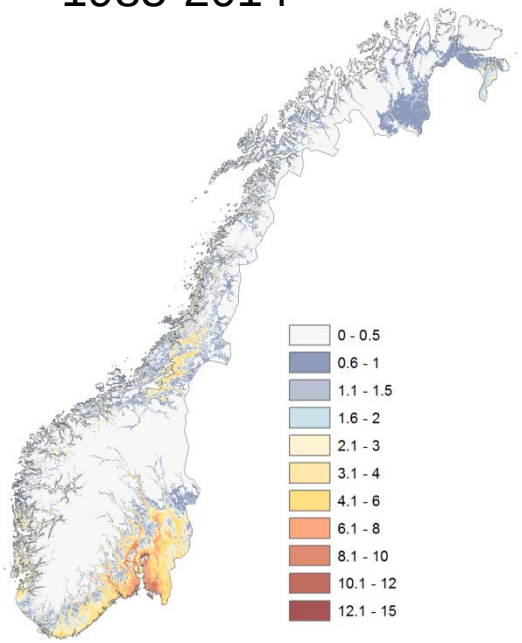
1961-90

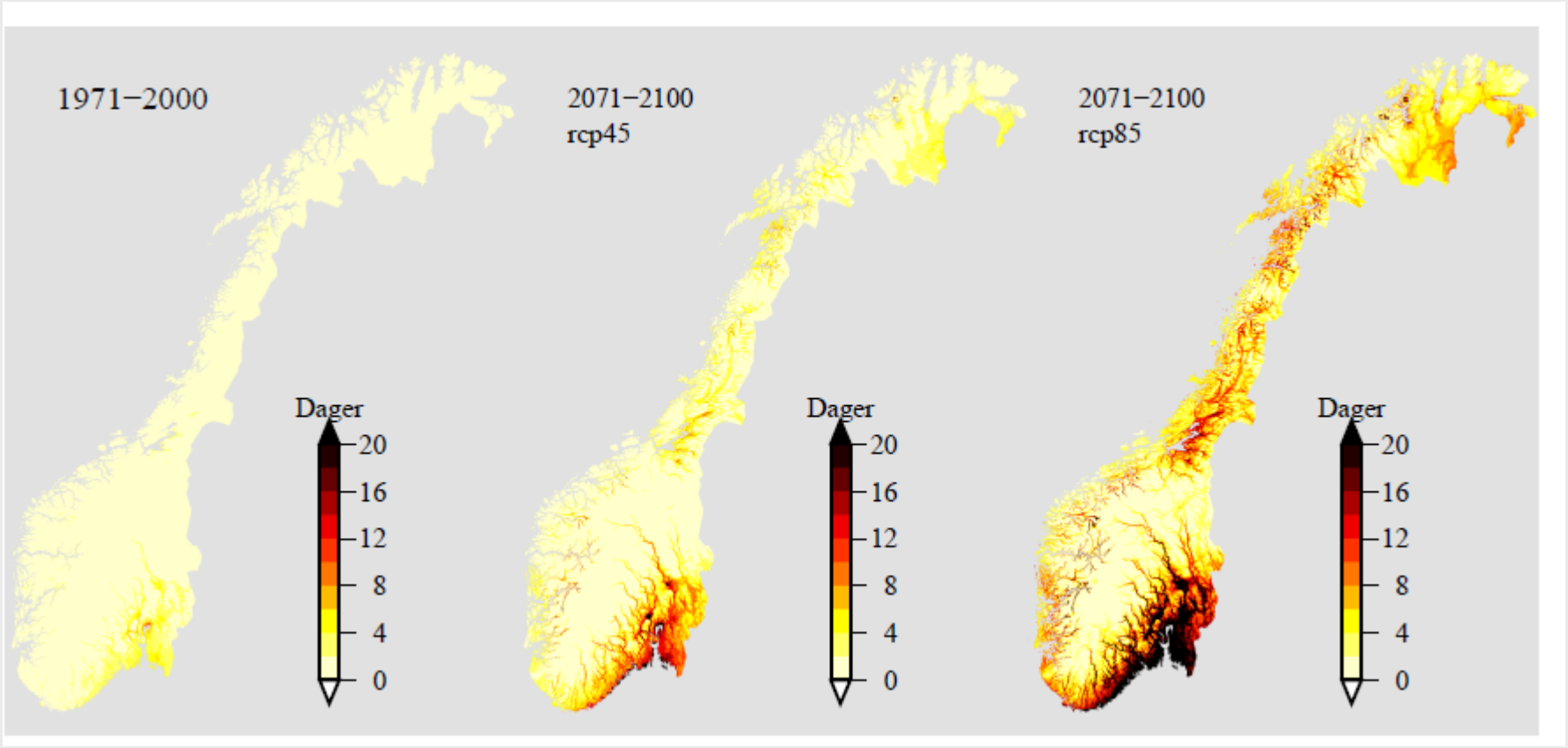


1971-2000

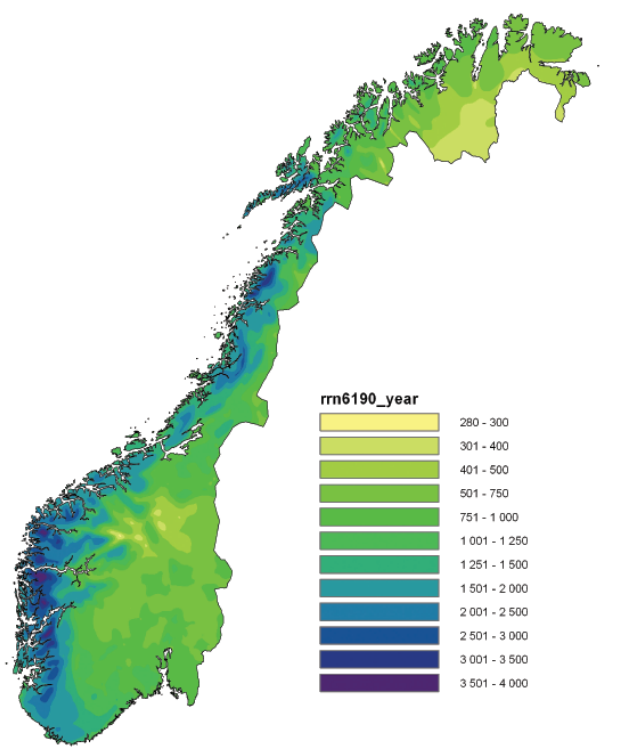


1985-2014

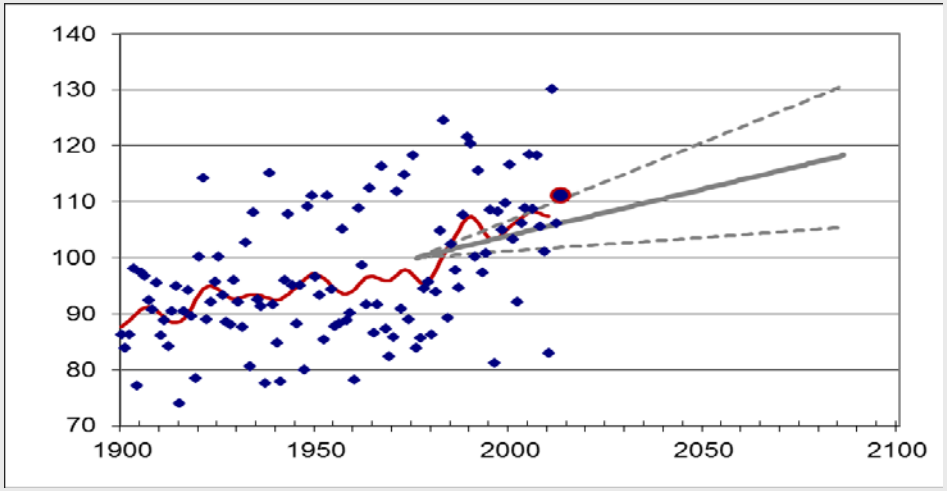



1971–2000
Dager
20
16
12
8
4
0
2071–2100
rcp45
Dager
20
16
12
8
4
0
2071–2100
rcp85
Dager
20
16
12
8
4
0

General projections: Precipitation

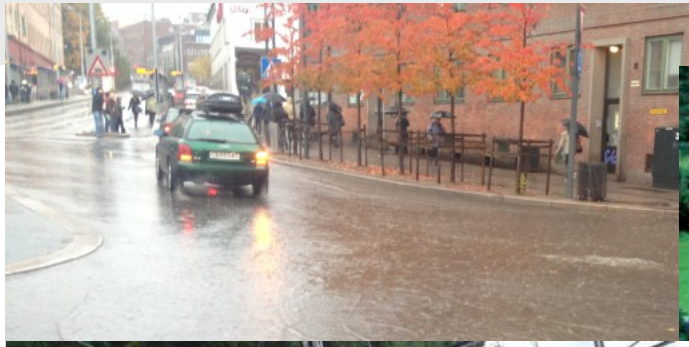


Annual precipitation
Period: 1961-90

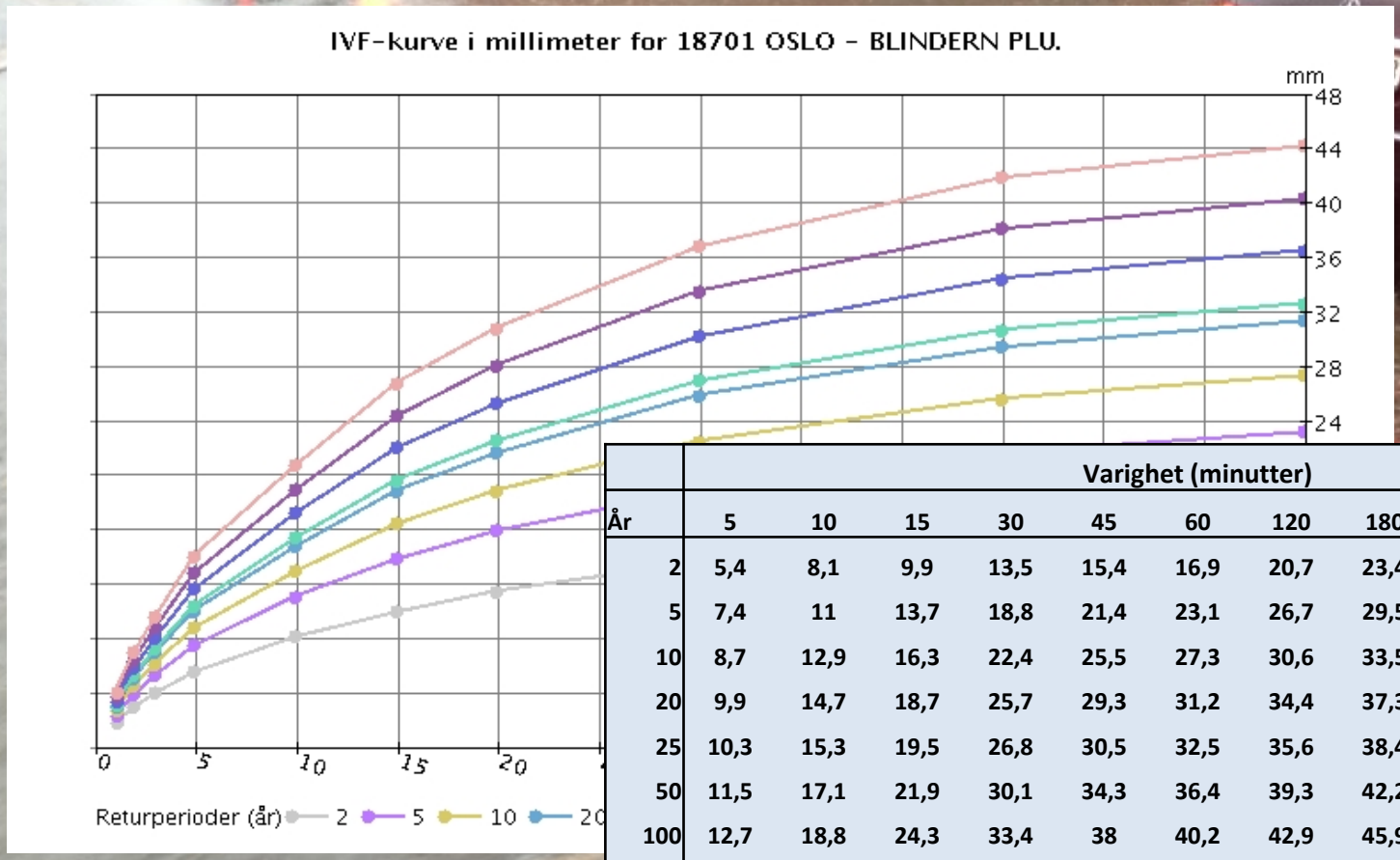


Region	Sesong	1961–90 til 2021–50: Endring (%) i nedbørsum			1961–90 til 2071–00: Endring (%) i nedbørsum		
		M	L	H	M	L	H
Norge	År	9,6	2,4	14,0	18,3	5,4	30,9
	Vinter DJF	11,1	3,8	18,4	21,4	8,5	39,9
	Vår MAM	10,0	3,7	20,0	19,4	7,2	41,5
	Sommer JJA	5,0	–1,6	9,7	9,2	–3,2	17,4
	Høst SON	12,2	2,1	16,1	23,3	4,6	33,4
NR-1 Østfold	År	6,7	1,5	12,1	12,2	2,7	22,2
	Vinter DJF	13,5	5,6	28,7	24,7	10,2	52,6
	Vår MAM	7,6	1,4	16,9	14,0	2,6	31,0
	Sommer JJA	–3,8	12,2	10,9	–7,0	–22,4	19,9
	Høst SON	9,2	–2,0	15,0	16,8	–3,7	27,5
NR-2 Østlandet	År	6,7	3,1	10,3	12,2	5,6	18,8
	Vinter DJF	15,8	7,0	26,6	28,9	12,9	48,8
	Vår MAM	7,6	2,9	15,5	14,0	5,4	28,5
	Sommer JJA	–2,4	–11,5	5,1	–4,4	–21,0	9,4
	Høst SON	8,2	1,0	12,5	15,1	1,8	22,9
NR-3 Sørlandet	År	4,6	-0,8	9,3	8,5	–1,5	17,0
	Vinter DJF	12,4	3,8	28,0	22,7	7,0	51,4
	Vår MAM	6,3	-0,4	16,6	11,6	–0,8	30,4
	Sommer JJA	–4,6	–15,4	5,0	–8,5	–28,2	9,2
	Høst SON	3,3	–4,8	8,7	6,0	–8,8	16,0

… We need to plan for future climate;- but in some ways we are not even adapted to present climate……!



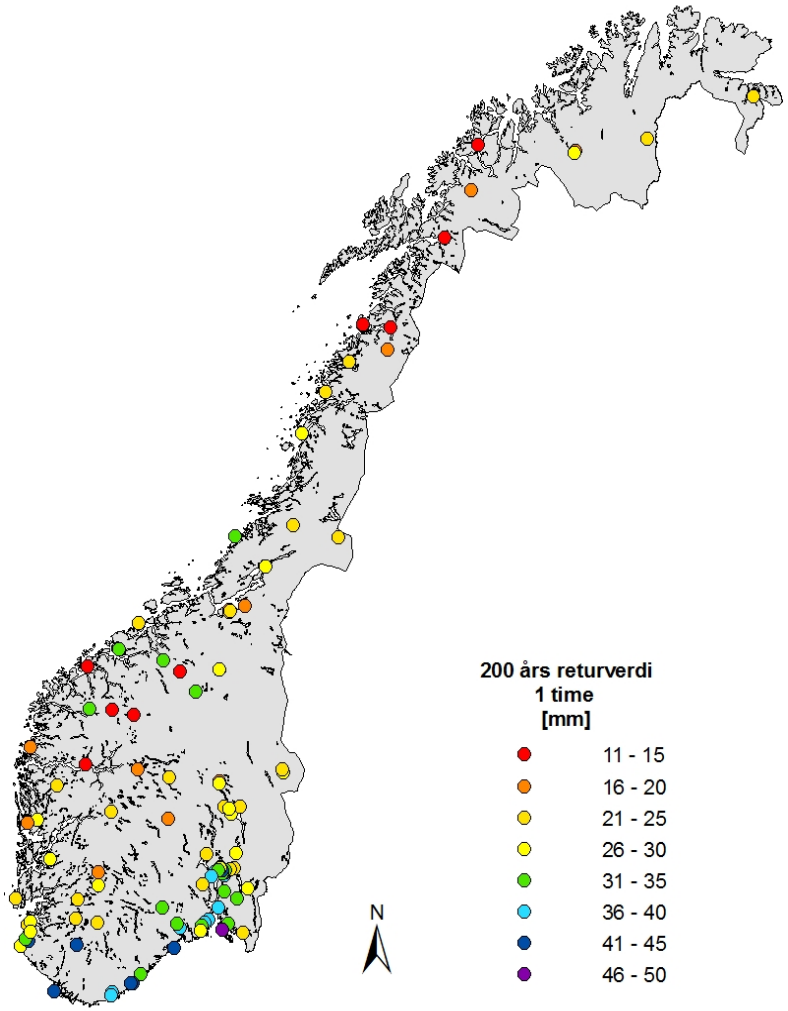
Design values for rainfall (IDF-statistics) are freely available at the NIFS and NCCS web-sites (www.klimaservicesenter.no)

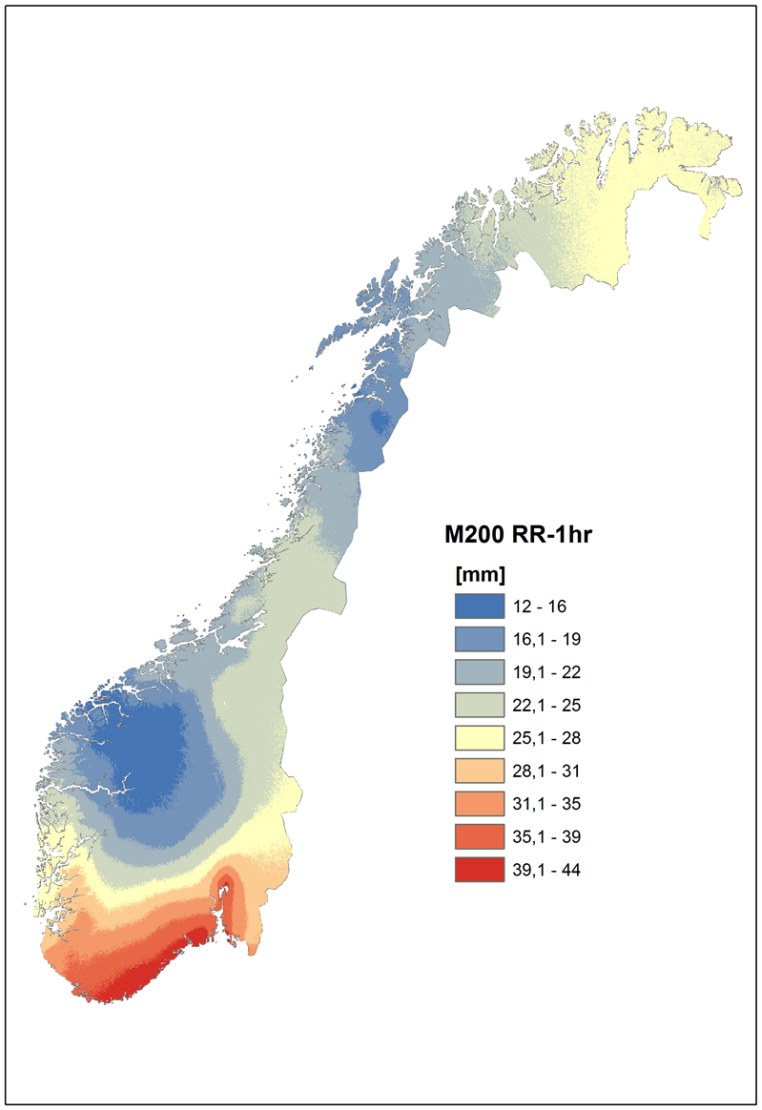


	Varighet (minutter)										
År	5	10	15	30	45	60	120	180	360	720	1440
2	5,4	8,1	9,9	13,5	15,4	16,9	20,7	23,4	28,5	34,6	41,5
5	7,4	11	13,7	18,8	21,4	23,1	26,7	29,5	35,4	41,9	50,1
10	8,7	12,9	16,3	22,4	25,5	27,3	30,6	33,5	40	47,1	55,3
20	9,9	14,7	18,7	25,7	29,3	31,2	34,4	37,3	44,3	51,8	60,5
25	10,3	15,3	19,5	26,8	30,5	32,5	35,6	38,4	45,6	53,1	62,2
50	11,5	17,1	21,9	30,1	34,3	36,4	39,3	42,2	49,9	57,9	67,4
100	12,7	18,8	24,3	33,4	38	40,2	42,9	45,9	54,2	62,6	71,7
200	13,9	20,6	26,6	36,7	41,8	44,1	46,6	49,6	58,3	67	76,9

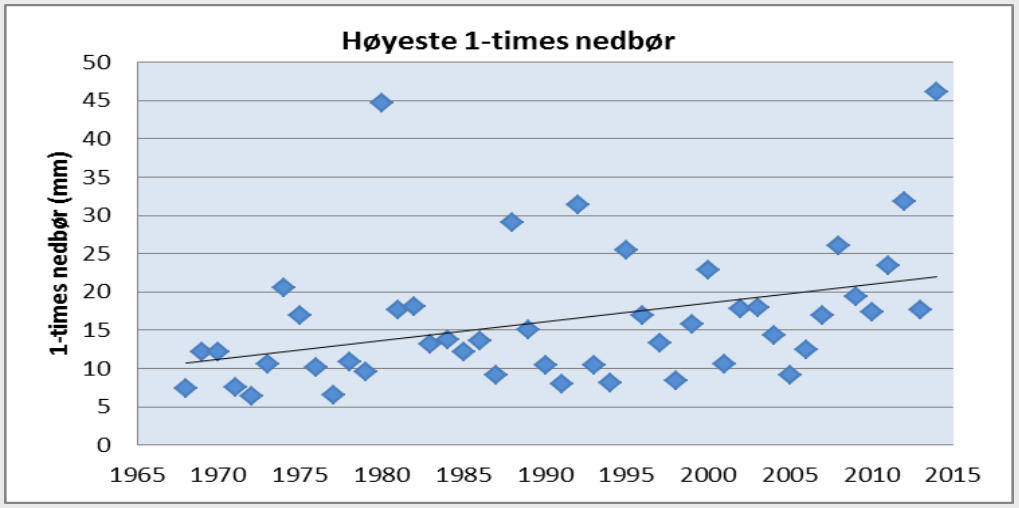
Foto: Mai-Linn Finstad

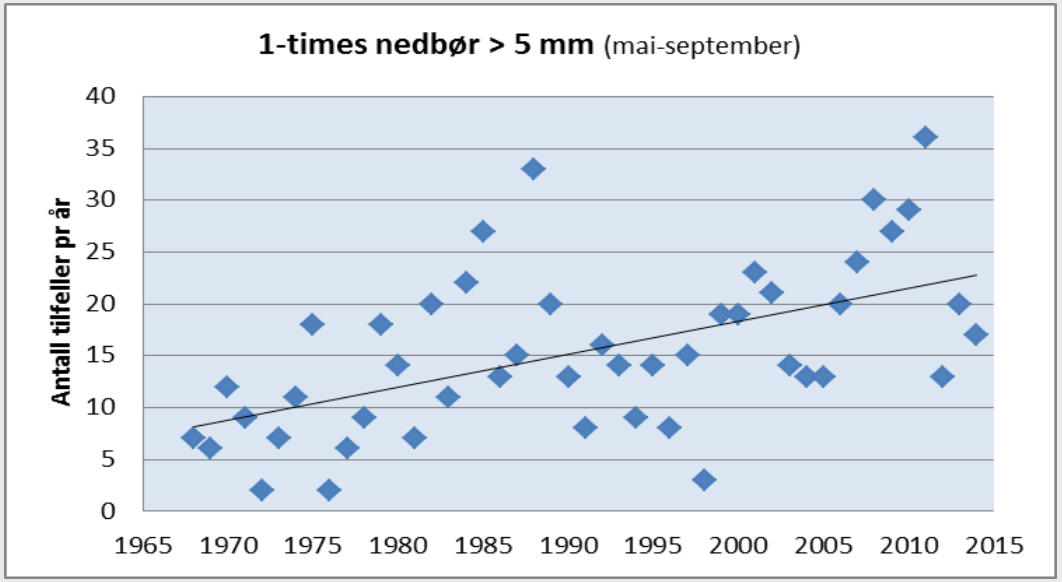
1-h rainfall for return period 200 years





1-hour rainfall Oslo-Blindern 1968-2014





Climate factors for Norwegian regions:

Element: Heavy* 1-day rainfall (0,05 %-value, i.e. 1-2 events/year)

Time slices: From 1961-90 (1971-2000) to 2071-2100

	1-day (*0,05 percentil)					
	«Klima i Norge, 2009»		RCP4.5		RCP8.5	
Region	Med	L - H	Med	L - H	Med	L- H
R1: Østfold	**1,19**	1,19 - 1,26	**1,10**	1,04 - 1,23	**1,19**	1,14 - 1,32
R2: Østlandet	**1,14**	1,08 - 1,19	**1,11**	1,04 - 1,19	**1,17**	1,14 - 1,30
R3: Sørlandet	**1,11**	1,05 - 1,19	**1,08**	1,01 - 1,15	**1,14**	1,11 - 1,23
R4: Sørvestlandet	**1,18**	1,09 - 1,23	**1,06**	1,03 - 1,13	**1,16**	1,11 - 1,22
R5: Sunnhordland/Ryfylke	**1,14**	1,03 - 1,26	**1,07**	1,02 - 1,12	**1,14**	1,08 - 1,21
R6: Nordhordl/ Sogn&Fj.	**1,13**	0,97 - 1,28	**1,08**	1,02 - 1,13	**1,14**	1,08 - 1,22
R7: Dovre/ Nord Østerdal	**1,21**	1,10 - 1,30	**1,11**	1,06 - 1,24	**1,21**	1,15 -1,40
R8: Møre & Romsdal	**1,14**	1,01 - 1,31	**1,10**	1,02 - 1,13	**1,18**	1,04 - 1,21
R9: Inntrøndelag	**1,20**	1,06 - 1,29	**1,13**	1,03 - 1,18	**1,22**	1,11 - 1,28
R10: Trøndelag / Helgeland	**1,14**	1,01 - 1,33	**1,11**	1,04 - 1,14	**1,21**	1,10 - 1,24
R11: Hålogaland	**1,17**	1,08 - 1,23	**1,13**	1,07 - 1,19	**1,23**	1,09 - 1,30
R12: Finnmarksvidda	**1,21**	1,05 - 1,31	**1,18**	1,14 - 1,32	**1,27**	1,17 - 1,42
R13: Varanger	**1,26**	1,08 - 1,35	**1,17**	1,13 - 1,36	**1,29**	1,18 - 1,48
	1,1 – 1,3	**1,0 – 1,4**	**1,1 – 1,2**	**1,0 – 1,4**	**1,1 – 1,3**	**1,0 – 1,5**

Communication with key users is crucial!

- Meetings/seminars with “homogeneous” user groups
- Working together in projects to define the needs
- Collaboration on tailoring products

Communication with users

1. “The Climate Watch”: A three-level phone and e-mail service
2. Seminars/ meetings focused on specific user groups
3. http://klimaservicesenter.no/
   Presently a web-site with limited contents,

… but a major activity is…

Norwegian
Meteorological
Institute

Thanks for your attention!