Designing forest access to meet future challenges

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SURGE Project

St. Petersburg

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UNI FREIBURG

Outline

1. Basics of forest access

2. Road characteristics

3. Challenges and solution strategies

- 3.1 Access to timber resources
- 3.2 Emergency access
- 3.3 Climate change
- 3.4 Technical advancement

4. Summary

1. Basics of forest access

Functions of forest access

1. Enable people to access forest area/stands
2. Connects to public infrastructure (most often public road network)

1. Basics of forest access

- In middle Europe forest roads are the most common mean of forest access
- Access to forests by roads is precondition for any forest management and it allows the use of forest for different purposes/functions

1. Basics of forest access

Forest management

1. Basics of forest access

Timber transport

90% of timber transports by trucks

Long wood hauling
max. stem length 21 m

1. Basics of forest access

Short wood transport

- average payload 20 t

1. Basics of forest access

Recreation

1. Basics of forest access

Sports

1. Basics of forest access

Fire fighting

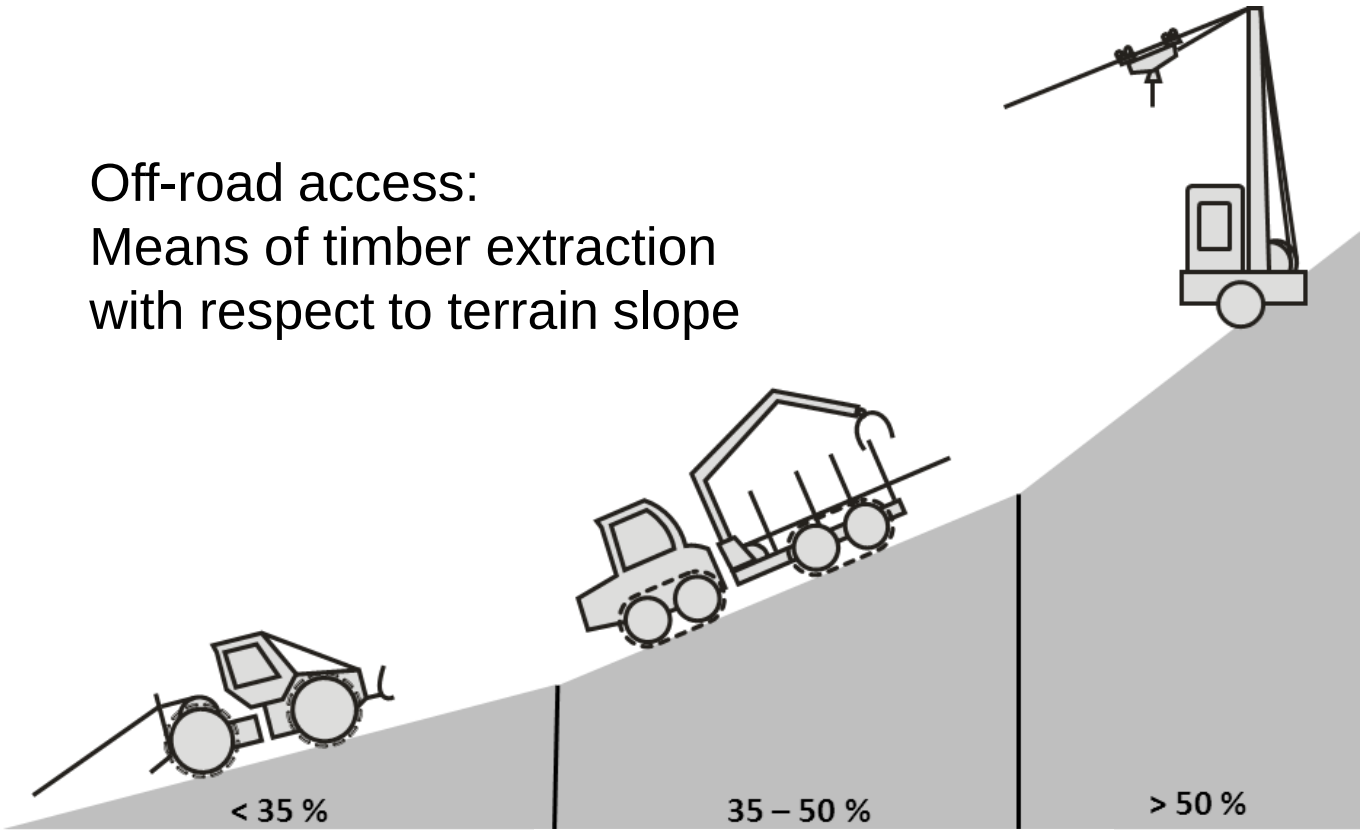
Bild: feuerwehr-landwehrhagen.de, 2013

1. Basics of forest access

- Any access system consists of road transportation and off-road transportation based on
  - Road network for road transportation (connecting function, long distance transport)
  - Off-road access for accessibility of forest stands (access function, short distance transport)
- For off-road (stand) access forest roads are combined with skid trails/strip roads, tractor roads or cable lines

1. Basics of forest access

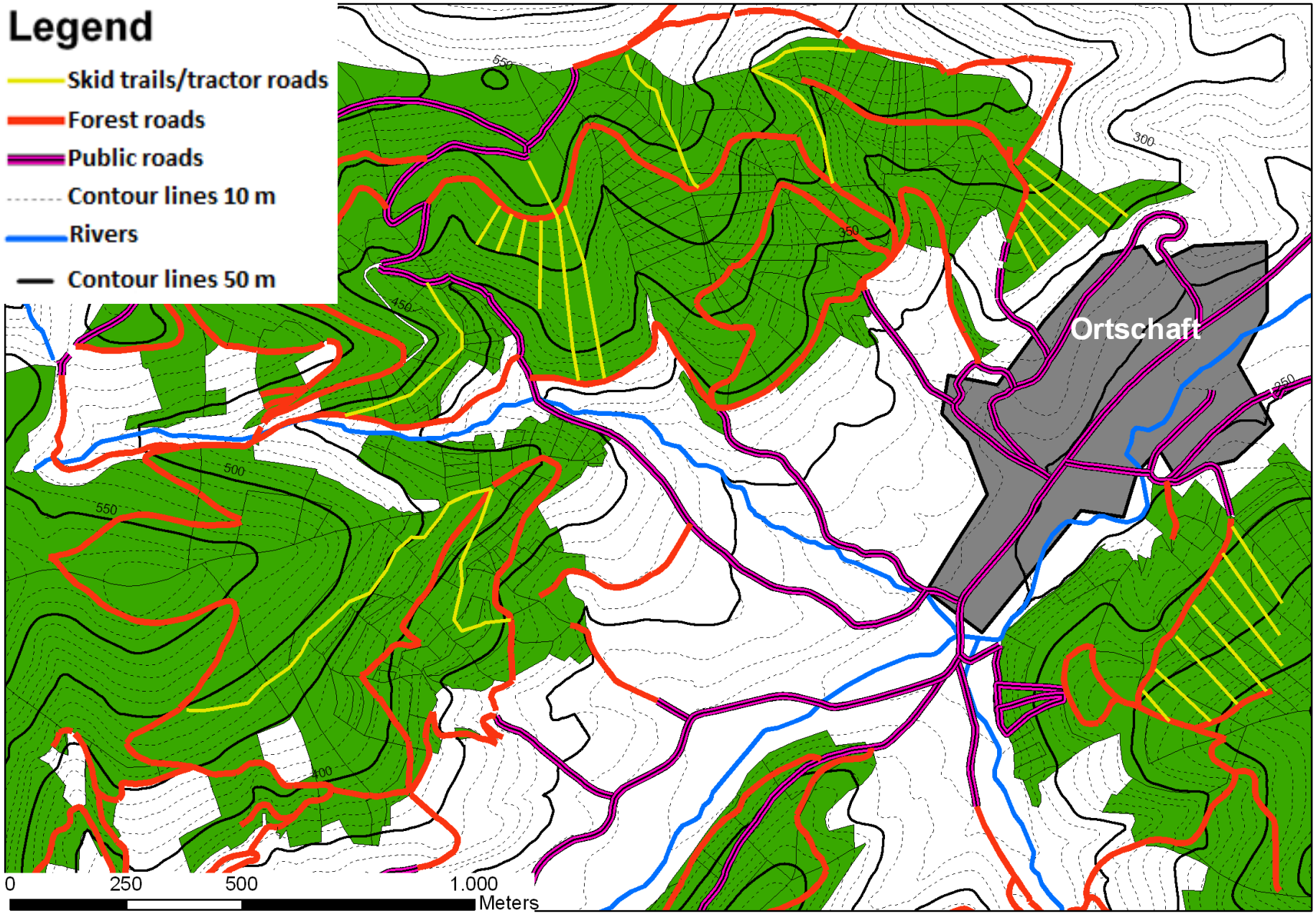
Off-road access:
Means of timber extraction
with respect to terrain slope



Skidding on skid trails or strip roads

Special machinery or machinery equipped with supporting winches (tethering winches)

Cable yarder


Legend
Skid trails/tractor roads
Forest roads
Public roads
Contour lines 10 m
Rivers
Contour lines 50 m
Ortschaft
550
300
350
450
500
550
400
250
0
250
500
1.000
Meters

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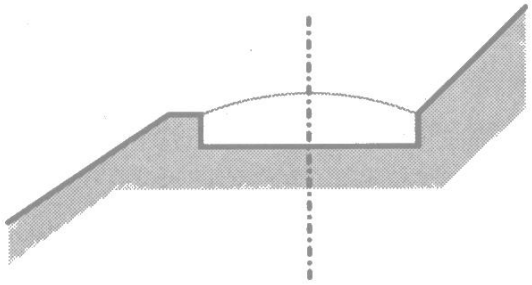
2. Road characteristics

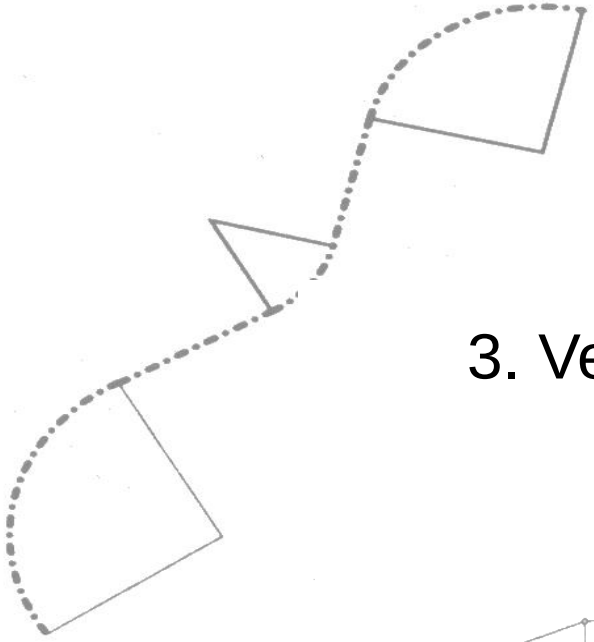
2. Road characteristics

Three perspectives to describe a forest road

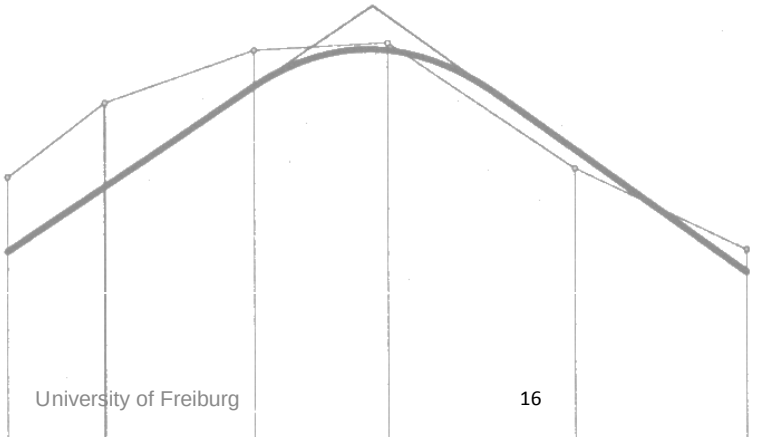


1. Cross section

2. Horizontal alignment

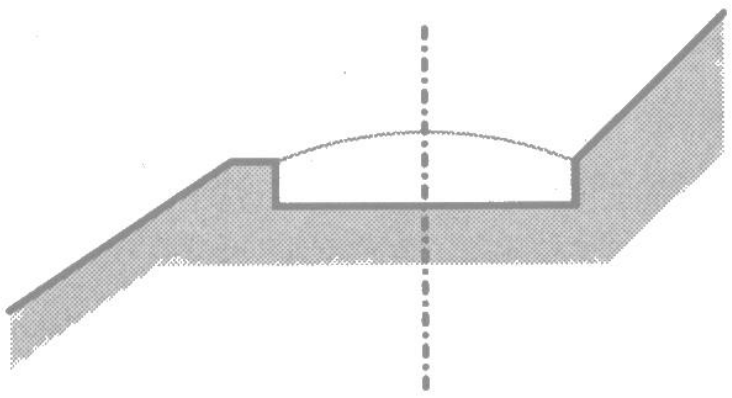


3. Vertical alignment



2. Road characteristics

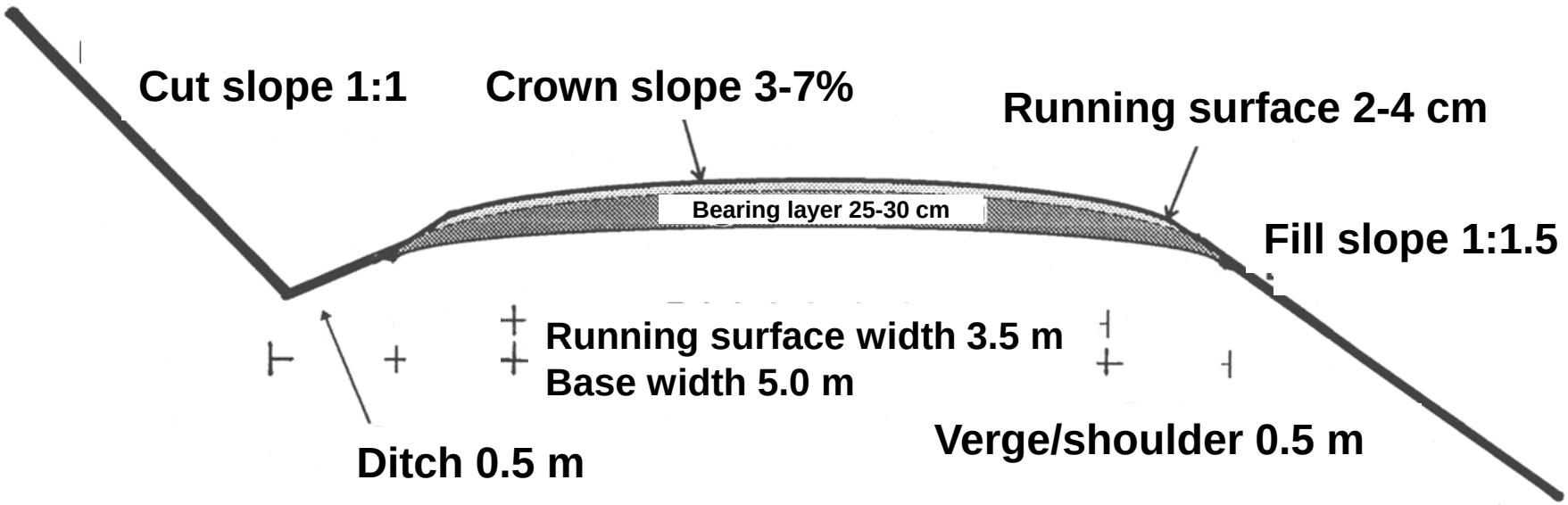
Cross section



Road width
Width of right-of-way
Road surface (type, shape/profile)
Verge
Ditch
Side slopes 1:1 and 1:1.5
Bearing capacity 80 to 90 MPa for M_E (E_{v2})

2. Road characteristics

Forest road with crown profile



2. Road characteristics

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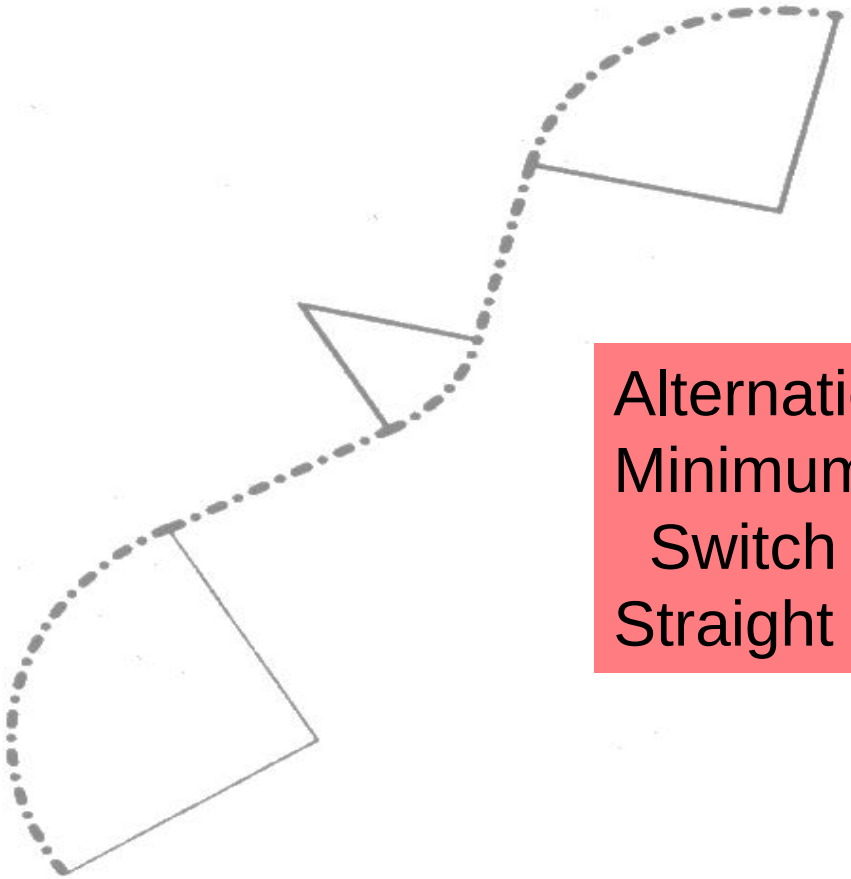
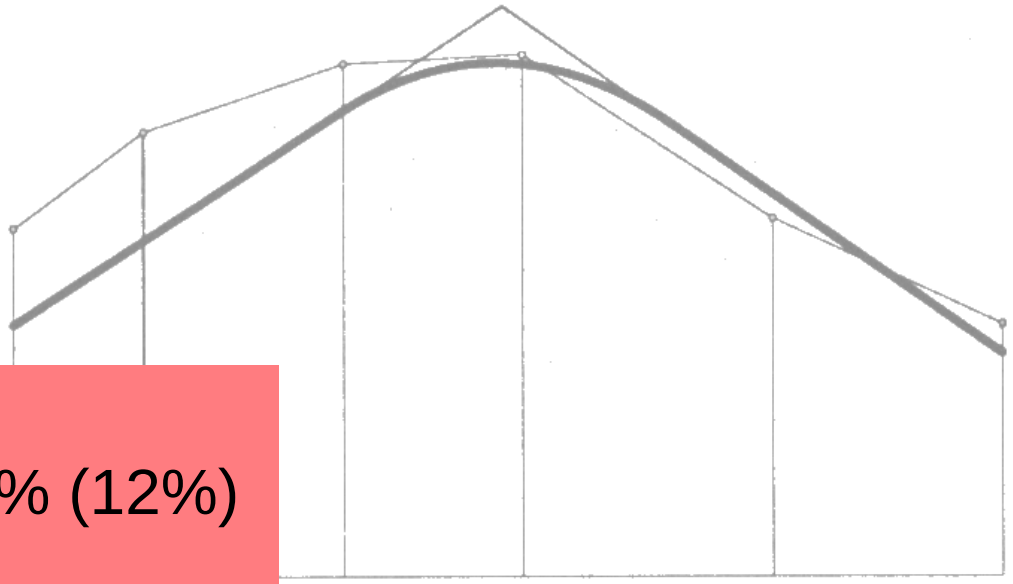
Horizontal alignment



Alternation of curves and
Minimum curve radius 20 m/35 m
Switch backs 12 m
Straight line segments >25 m

2. Road characteristics

Vertical alignment



Minimum/maximum
longitudinal gradient 2-10% (12%)
Vertical curves (10 m/%)
(crest r=400, sag r=200)

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3.1 Access to timber resources

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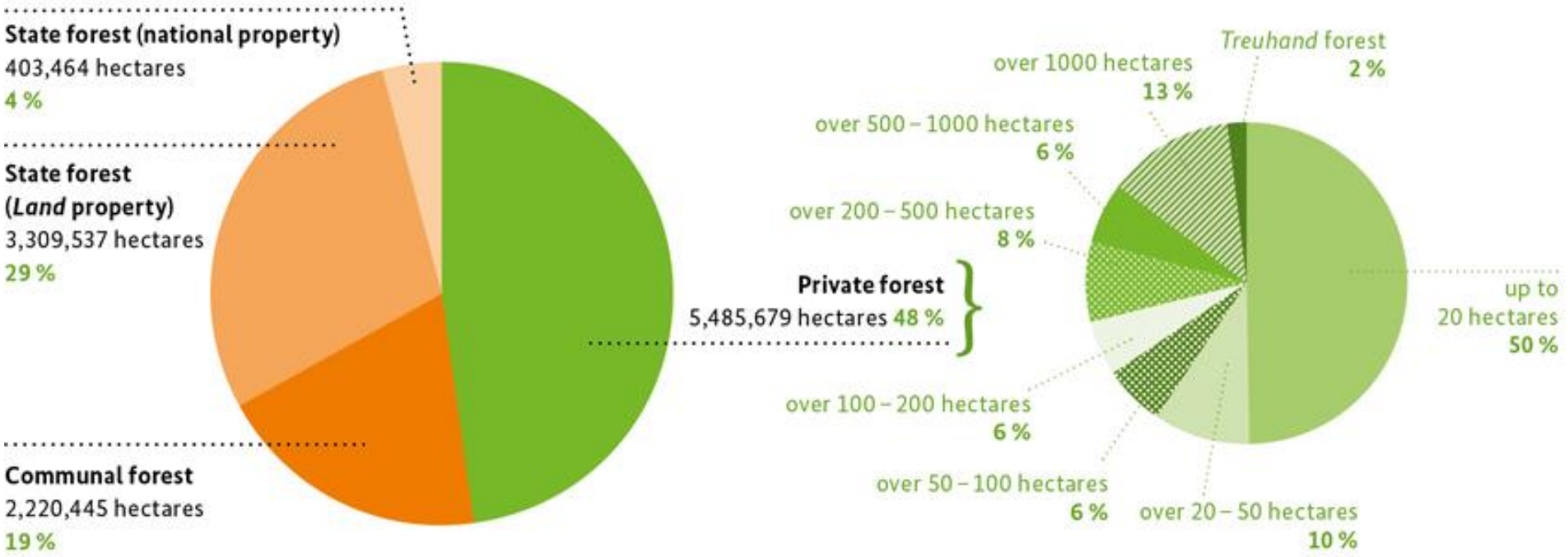
Forest area by type of ownership



Basis: : Total forest 11,419,124 hectares

Source: *BMEL - BWI3 (3rd National Forest Inventory)*

3.1 Access to timber resources

Forested land and growing stock by ownership [1000 ha, 1000 m³ over bark]

	State forest	Communal forest	Federal forest	Private forest	All types of ownership
Forested land	3,310 (29%)	2,220 (19%)	403 (4%)	5,486 (48%)	11,419 (100%)

Source: BWI III 2012

3.1 Access to timber resources

Forested land and growing stock by ownership [1000 ha, 1000 m³ over bark]

	State forest	Communal forest	Federal forest	Private forest	All types of ownership
Forested land	3,310 (29%)	2,220 (19%)	403 (4%)	5,486 (48%)	11,419 (100%)
Growing stock	1,024,050 (28%)	691,561 (19%)	90,000 (2%)	1,857,085 (51%)	3,662,972 (100%)

Source: BWI III 2012

3.1 Access to timber resources

2012	Growth [Mio. m³ u. b.]*	Harvesting volume [Mio. m³ u. b.]*	Potential use [Mio. m³ u. b.]
State Forest	28,6	22,1	6,5
Federal Forest	2,5	1,6	0,9
Community Forest	19,1	15,3	3,8
Private Forest	49,1	36,7	12,4
Total	**99,2**	**75,7**	**23,5**

Source: BWI III 2012

3.1 Access to timber resources

Small areas of private woodlots

Bernd Wippel

3.1 Access to timber resources

Province	Provincial Forest [m/ha]
Rheinland-Pfalz	49.5
Bayern	35.0
Sachsen	26.2
Baden-Württemberg*	52.0
NRW*	39.0

*** All types of ownership**

Road density [lfm/ha] with index of road density/100 m^3 stocking volume/ha [over bark]

Source: In PEFC RLP 2015: (Zentralstelle der Forstverwaltung RLP, AFLUE RLP), PEFC BW 2015, PEFC Bayern 2015, PEFC NRW 2016, LFP Sachsen 2002, BWI III 2012

3.1 Access to timber resources

Province	Provincial Forest [m/ha]	Community forrest [m/ha]	Private Forest [m/ha]
Rheinland-Pfalz	49.5	38.1	21.8
Bayern	35.0	24.0	24.0
Sachsen	26.2	21.5	16.9
Baden-Württemberg*	52.0		
NRW*	39.0		

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Road density [lfm/ha] with index of road density/100 m^3 stocking volume/ha [over bark]

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3.1 Access to timber resources

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Province	Provincial Forest [m/ha]	Index [lfm/ha/ 100 m³]	Community forrest [m/ha]	Index [lfm/ha/ 100 m³]	Private Forest [m/ha]	Index [lfm/ha/ 100 m³]
Rheinland-Pfalz	49.5	16.3	38.1	13.1	21.8	6.7
Bayern	35.0	9.9	24.0	6.9	24.0	5.5
Sachsen	26.2	7.8	21.5	7.3	16.9	5.5
Baden-Württemberg*	52.0	13.8				
NRW*	39.0	12.6				

*** All types of ownership**

Road density [lfm/ha] with index of road density/stocking volume/ha [m³ over bark]

Source: In PEFC RLP 2015: (Zentralstelle der Forstverwaltung RLP, AFLUE RLP), PEFC BW 2015, PEFC Bayern 2015, PEFC NRW 2016, LFP Sachsen 2002, BWI III 2012

3.1 Access to timber resources

Objective
Enhanced access to timber resources of small private woodlands

Solution strategy

- Develop specific road design for private woodlots
- Establish Master plans of forest road networks in private woodlots
- Allow for higher road densities for easier access and comfort to ensure continuation of sustainable forest management (e.g. farmers in secondary employment can use farm machinery for timber extraction)
- Continue financial support for forest road construction

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3.1 Access to timber resources

3.2 Emergency access

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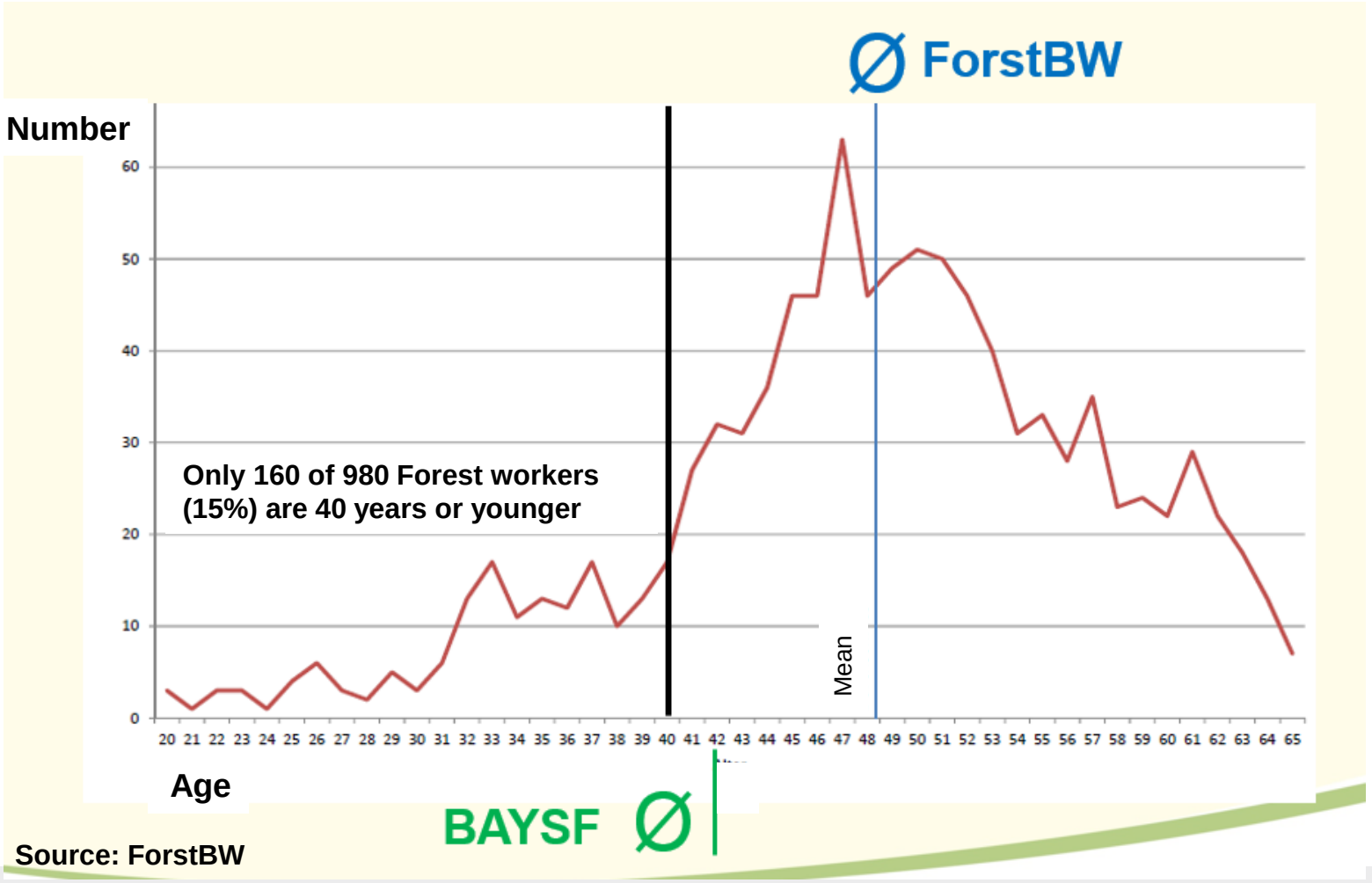
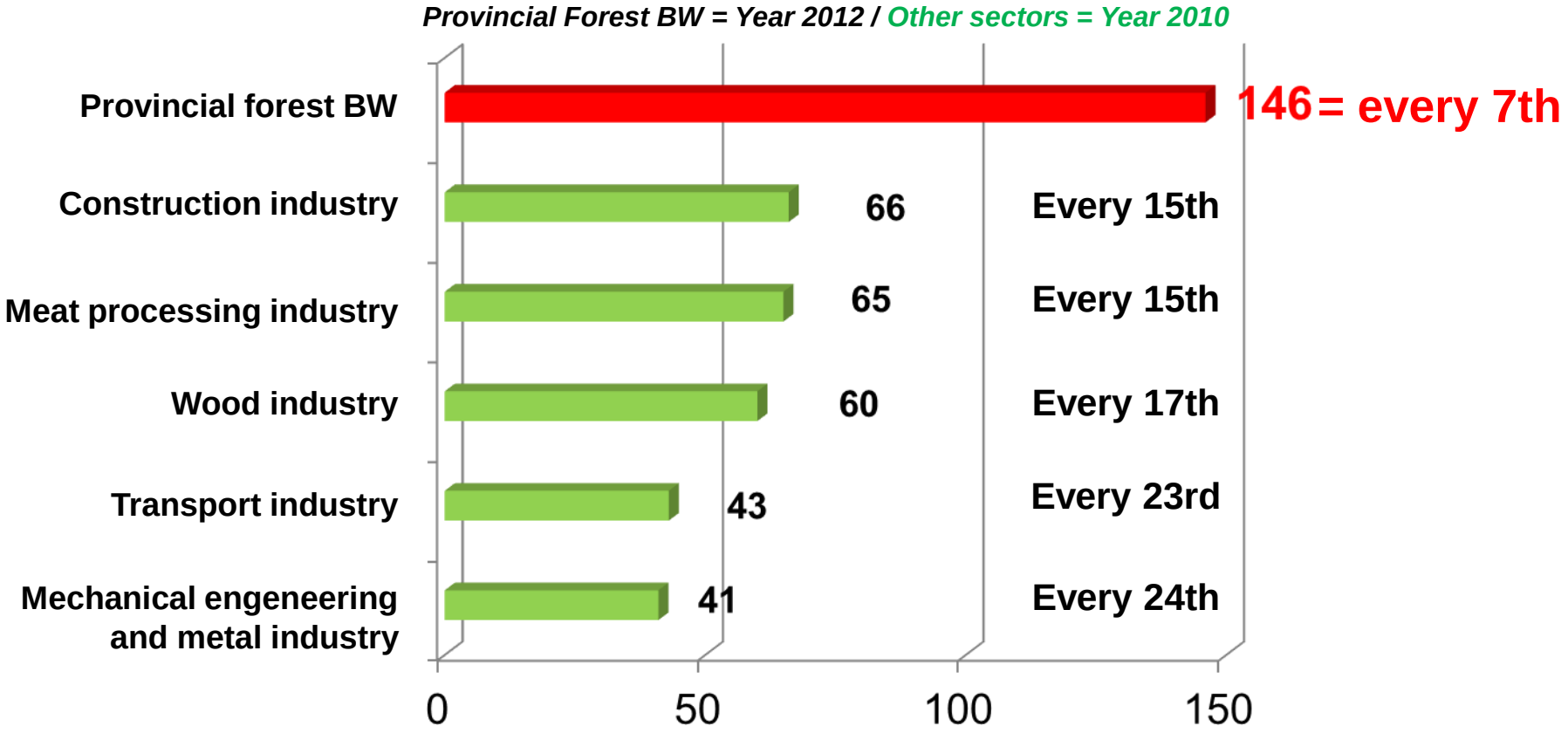
Demographics of forest workers in BW



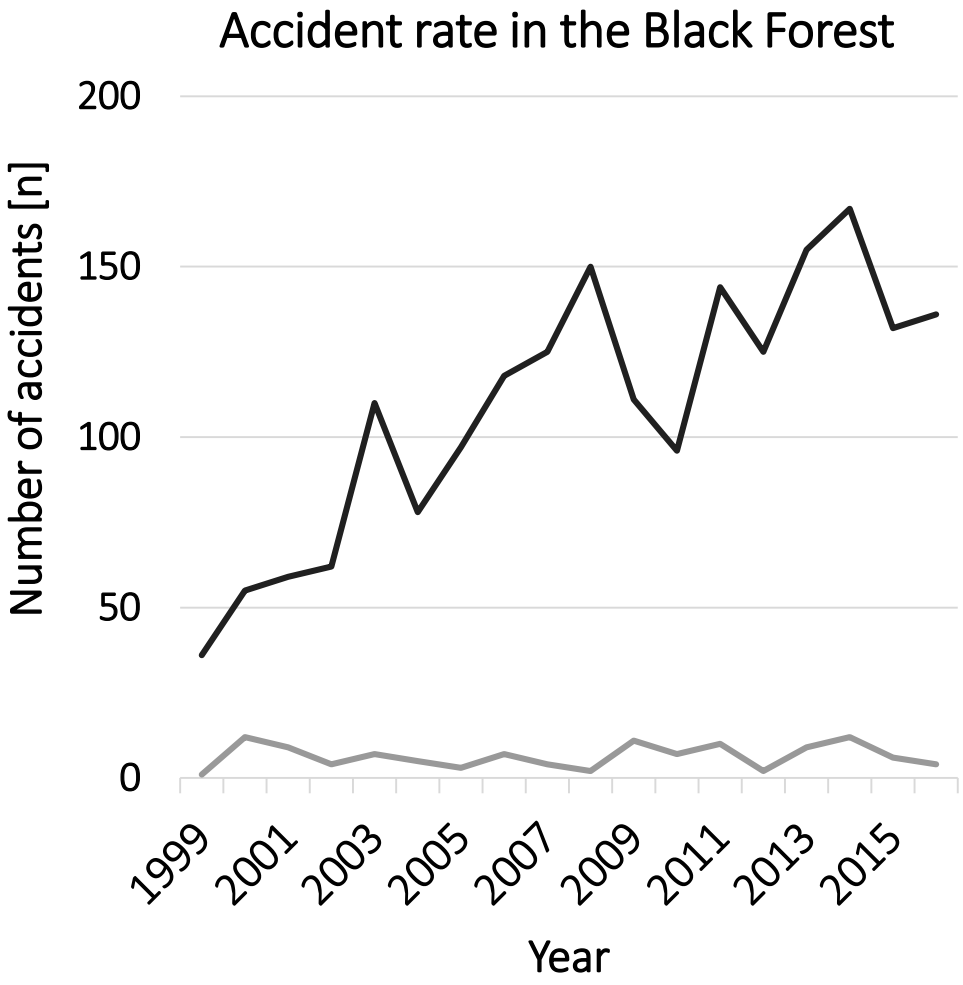
3.2 Emergency access

Accident rate in provincial forest Baden-Württemberg in comparison to other professions



Source: ForstBW

3.2 Emergency access



MTB and hiking accidents

Forest worker accidents

Source: Bergwacht Schwarzwald 2017

3.2 Emergency access

Objective:
All year forest access for efficient emergency rescue

Solution strategy

- Sufficient density of year round trafficable forest roads
- Assign easy to reach emergency meeting points
- Dynamic database of actual road condition for effective navigation
- Close cooperation with emergency services

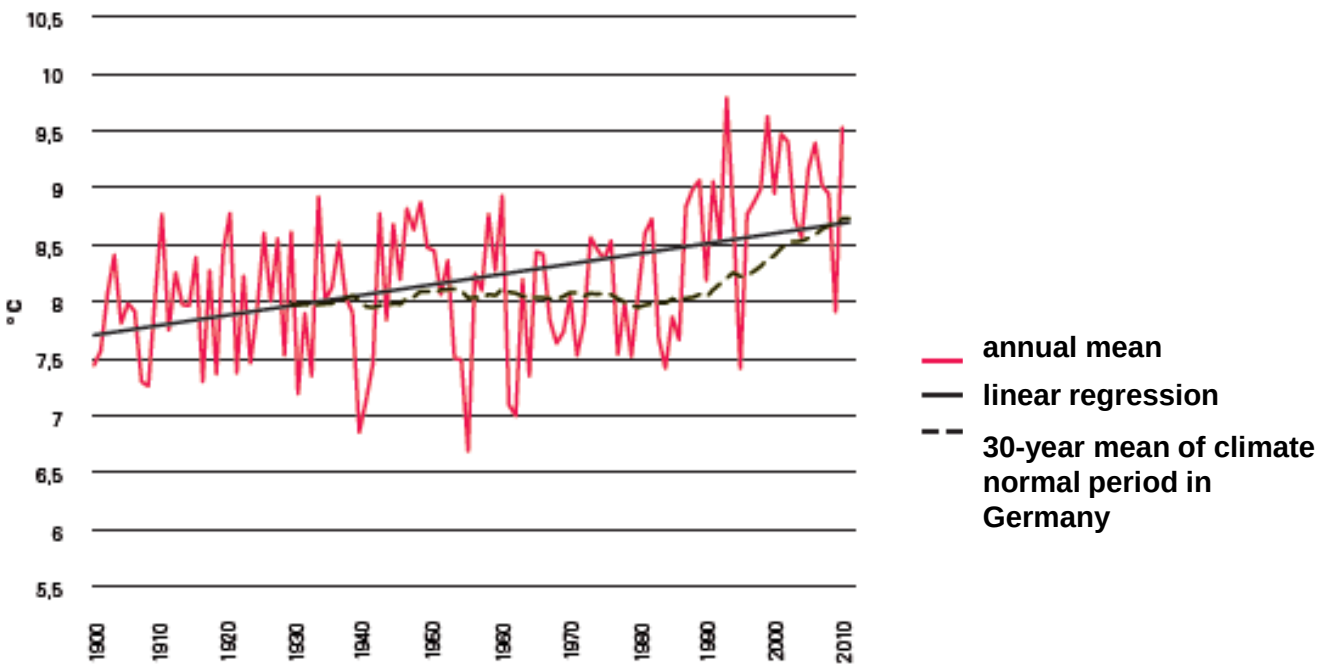
Outline

3.3 Climate change

- Year round precipitation, less frozen ground, higher risks of soil disturbance
- Heavy precipitation events with high risks of erosion and washouts
- Draught periods with road damage by losing fine particles (dust)
- Handling of unforeseen timber volumes
  - highly concentrated (windthrow, beatle infection)
  - scattered (infected single trees)

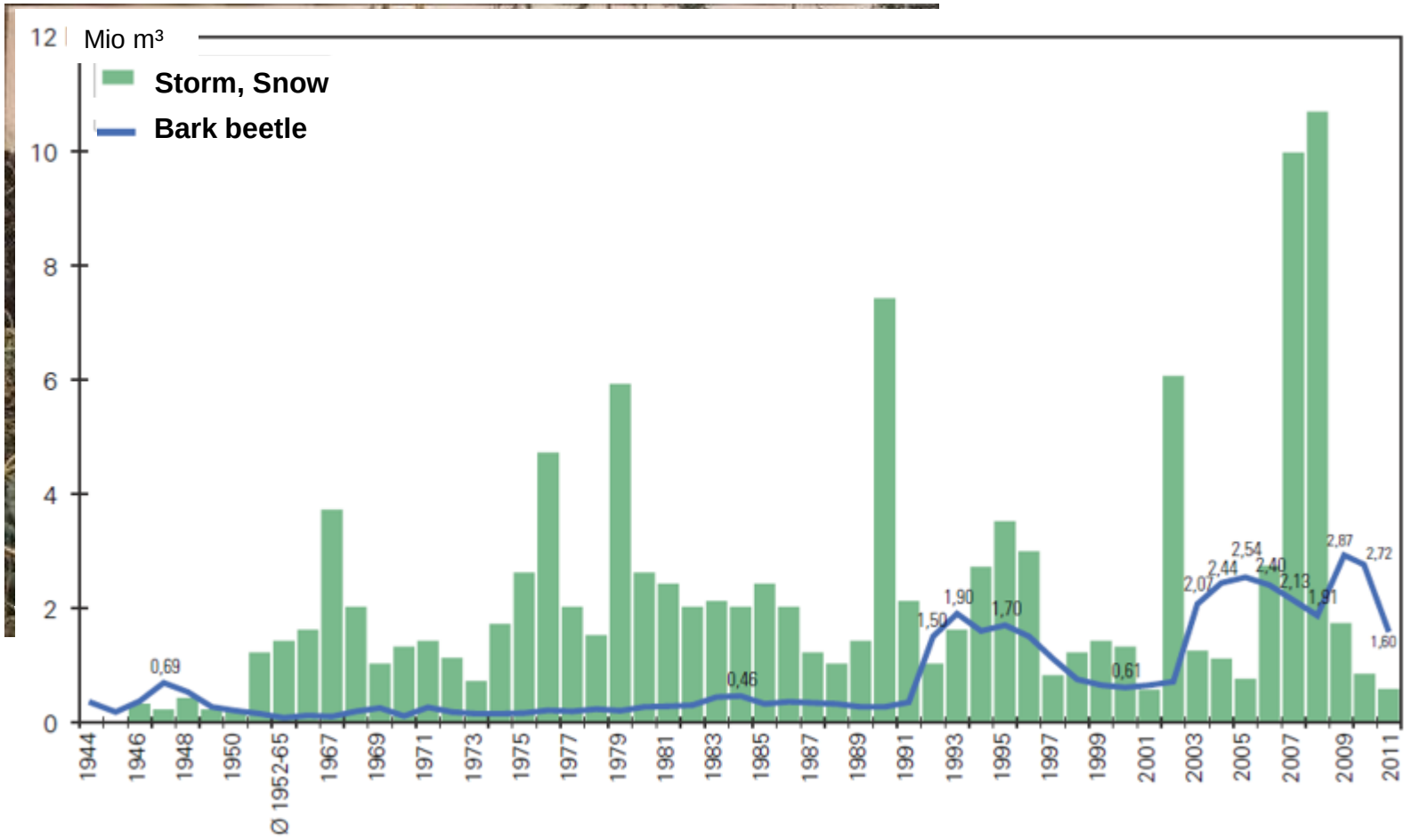
3.3 Climate change

Mean annual temperature in Baden-Württemberg (1901-2011)



Source: LUBW 2015.

3.3 Climate change



Source: Tomiczek 2012

3.3 Climate change

Objective:
Full range year round ready to use basic access

Solution strategy

- Needs adapted road network and off-road transportation system for reasonable extraction distances
- Integration of road network in overall transportation system including railway and waterways
- Ensure proper road profile/cross section for water run-off (crowning of road)

3.3 Climate change

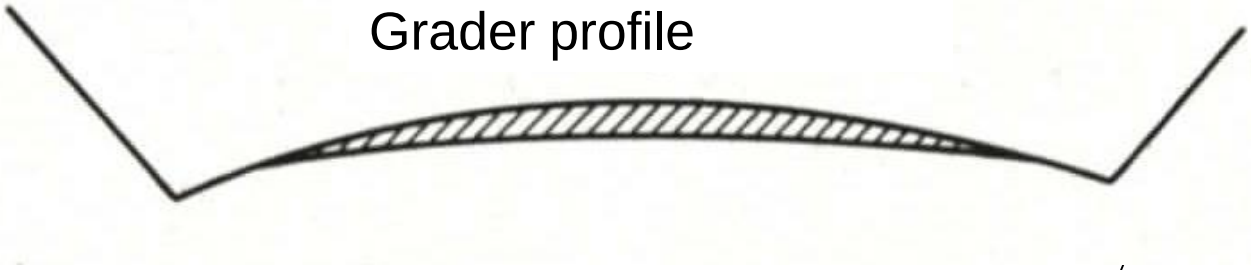
Objective:
Full range year round ready to use basic access

Solution strategy (continued)

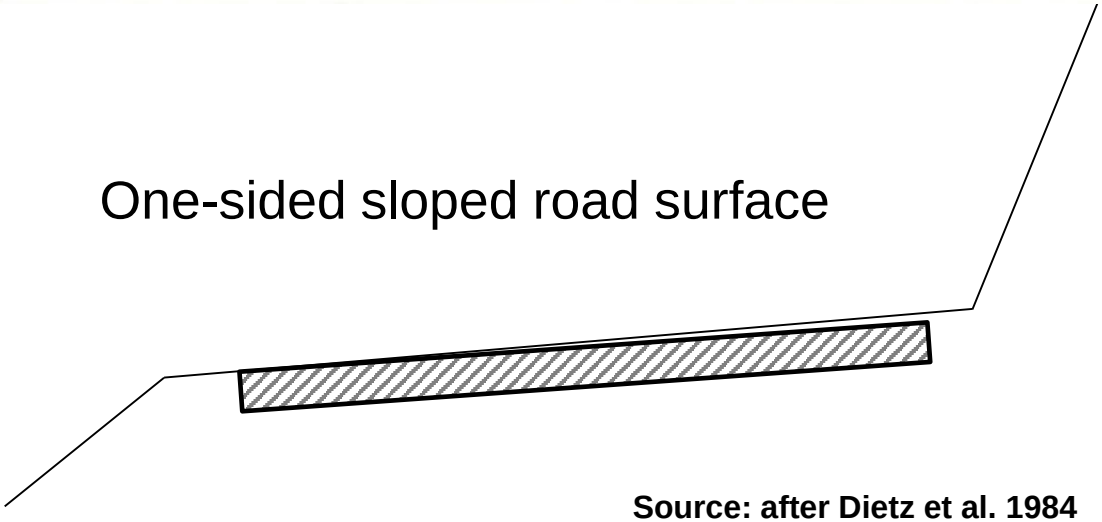
- Sufficient dimensioning of road drainage systems (ditches and culverts)
- Use of one sided sloped road profiles for easier maintenance (especially for forest roads in small woodlands with low traffic frequency)

Road profiles

Grader profile



One-sided sloped road surface



Source: after Dietz et al. 1984

3.3 Climate change

Objective:
Full range year round ready to use basic access

Solution strategy (continued)

- Sufficient dimensioning of road drainage systems (oversizing of ditches and culverts)
- Use of one sided road profiles for easier maintenance (especially for forest raods in small woodlands with low traffic frequency)
- Intensive road maintenance (more frequent re-profiling of road surface including ditch and culvert clearing)

3.3 Climate change

Objective:
Full range year round ready to use basic access

Solution strategy (continued)

- Change of road design: Reduction of maximum allowable road gradient

3.3 Climate change

Objective:
Full range year round ready to use basic access

Solution strategy (continued)

- Change of road design: Reduction of maximum allowable road gradient
- Increase number of cross drains and off-take ditches to avoid water accumulation in ditches
- Creation of retaining ponds in forest stands for minimizing peaks of surface run-off into aquatic systems

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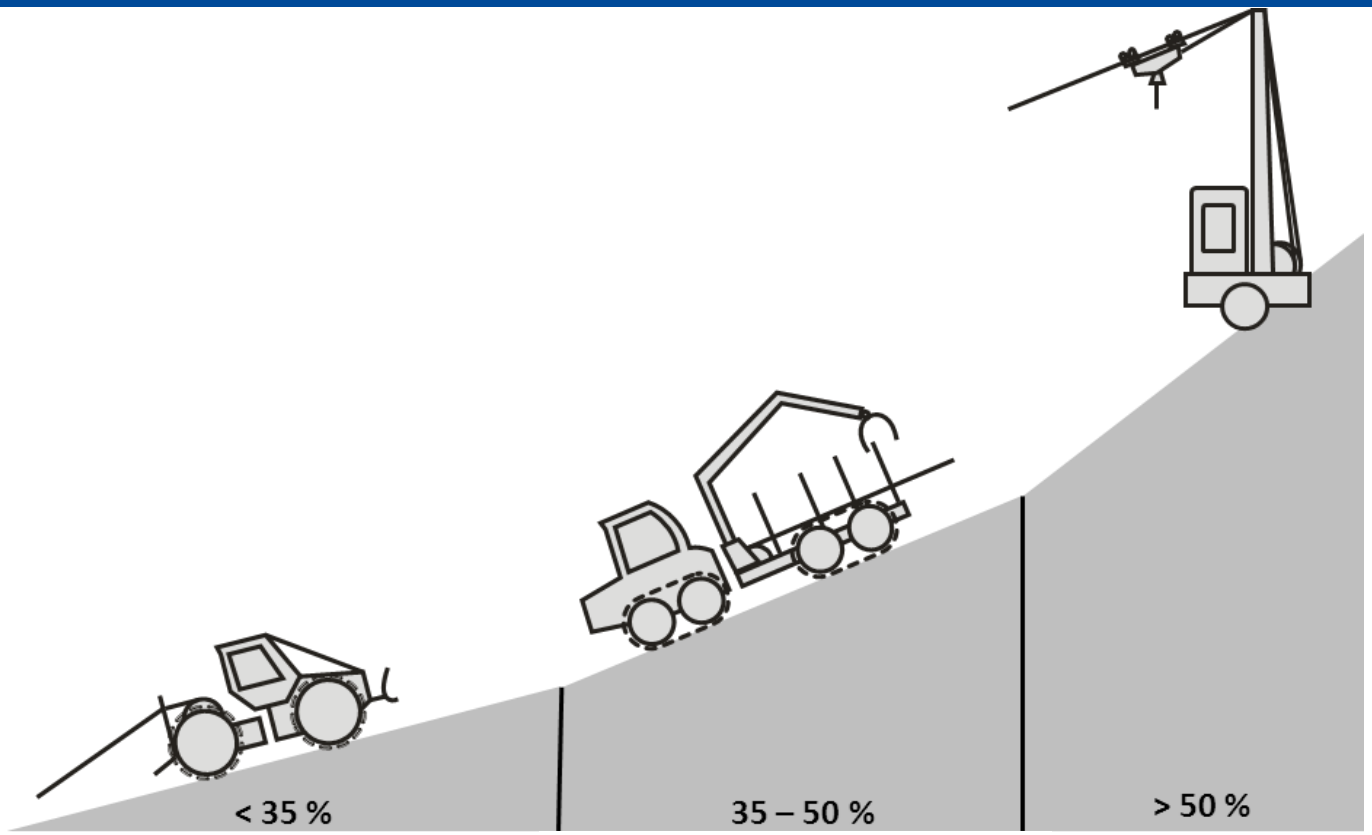
3.4 Technical advancements



Skidding on skid trails or strip roads

Machinery equiped with supporting winches (tethering winches)

Cable yarder

Supporting winch/Tethering winch (Synchro winch)

牵引绞盘机和同步绞盘机作为辅助

3.4 Technical advancements

CAT552 (with winch)
Cable assisted harvesting and forwarding

https://www.youtube.com/watch?v=FS0BWqhlM8A

3.4 Technical advancements

Model	CAT 330D L
Engine Capacity	200 kW
Gross Weight	47 900 kg
Work Width	2 920 mm
Boom Reach	13 900 mm

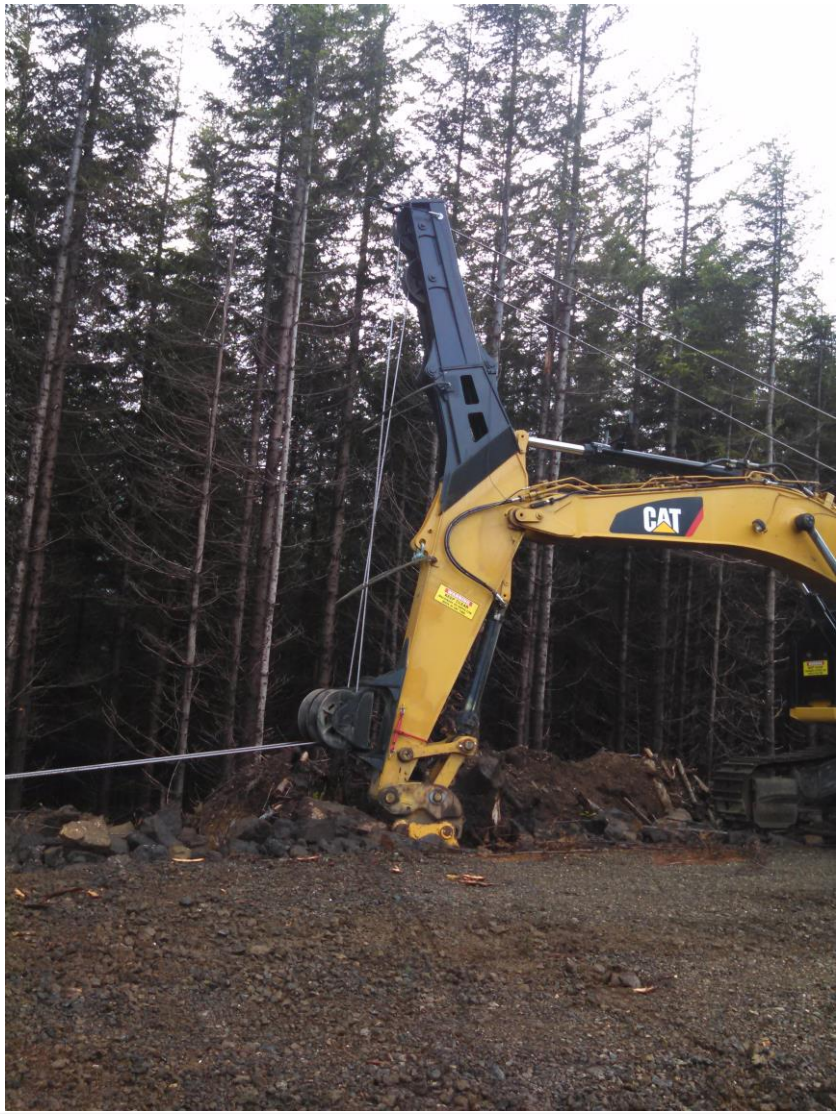
Model	CAT 552 (with Satco head)
Engine Capacity	226 kW
Gross Weight	36 124 kg (excl. Head)
Work Width	2 591 - 2 870 mm
Boom Reach	8 600 mm

Source: geniusstrand.de 2009, Caterpillar Inc. 2017

3.4 Technical advancements

All pictures taken by John Sessions Oregon State University

3.4 Technical advancements



3.4 Technical advancements

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Objective:
Adapt road network to technical innovation

Solution strategy

- Consider future changes in extraction techniques when designing forest roads for the next 50 years
- Favor top ridge roads in steep terrain for cable yarding and tethered ground based operations
- Less use of slope diagonal roads and valley roads
- Less use of tractor roads

Outline

4. Summary

Future challenges include

- Access to timber resources
- Emergency access
- Climate change
- Technical advancement

With thoughtful road network planning, road design, construction techniques and road maintenance concepts we should be able to handle these challenges.

Thank you for your interest!

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