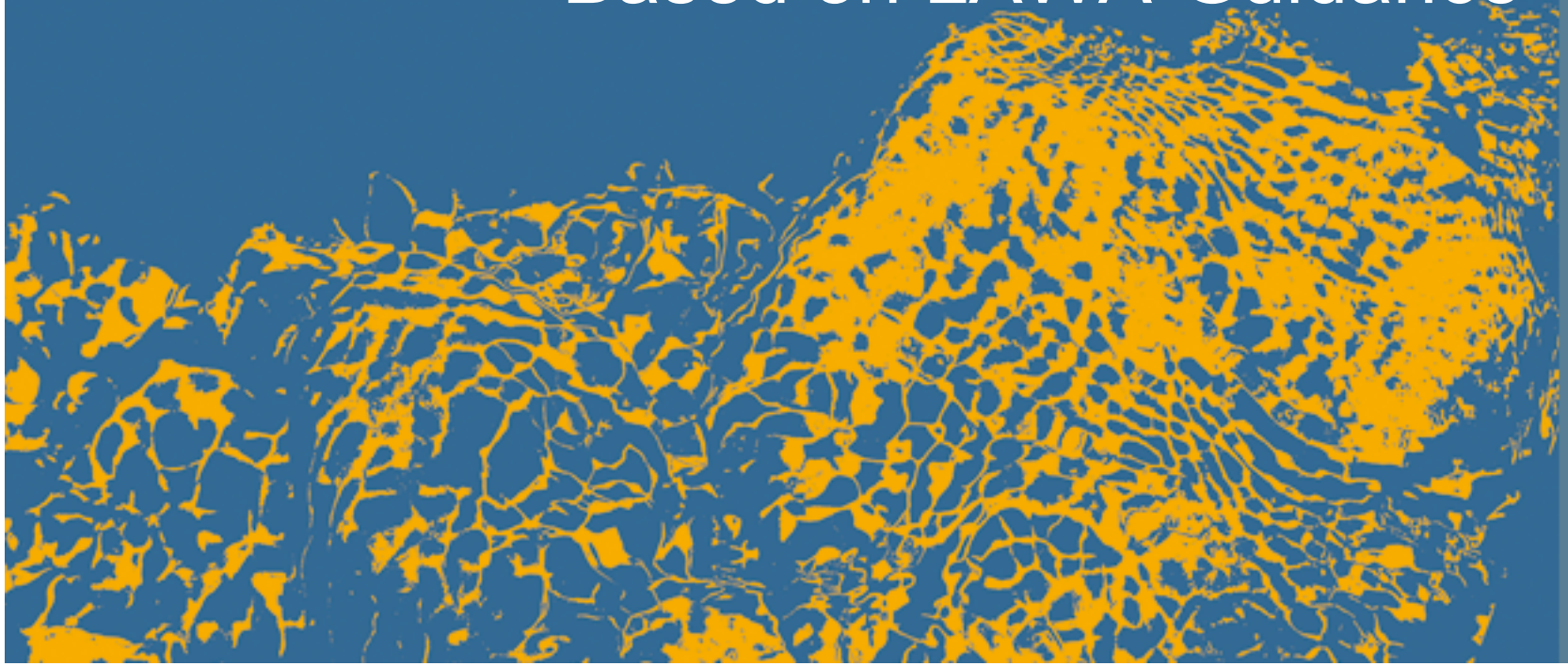
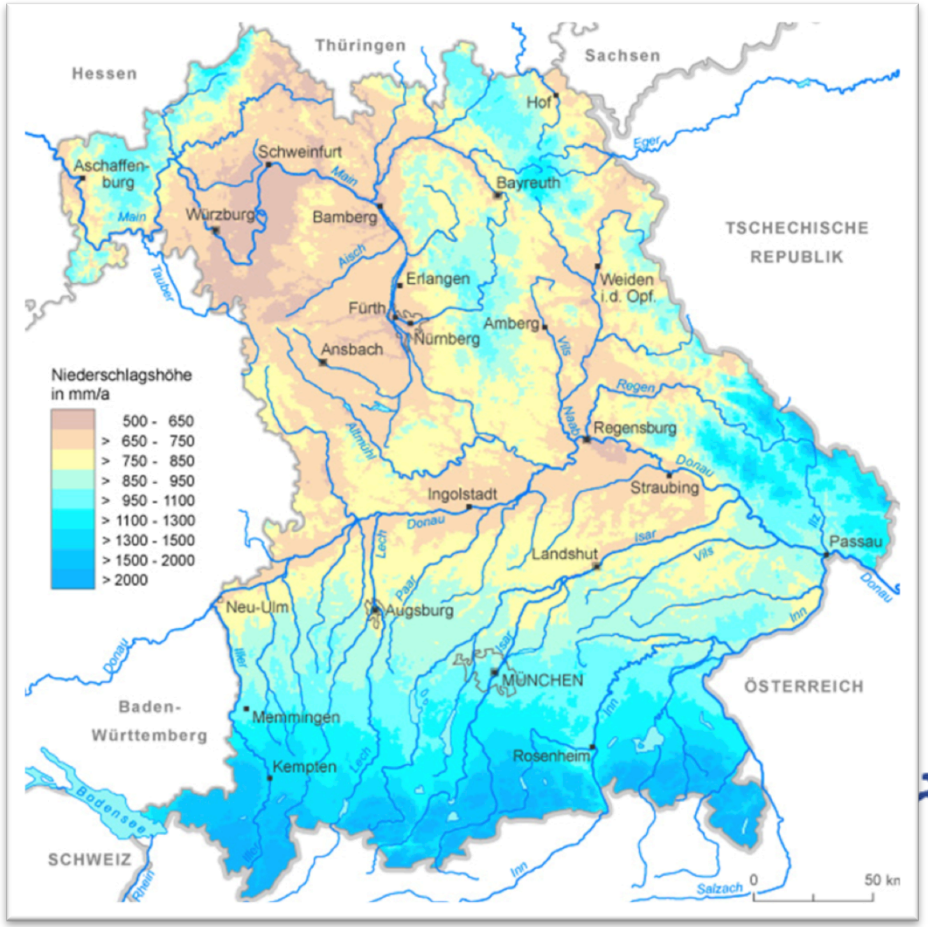
Bayerisches Landesamt für Umwelt

Low Flow Management in Bavaria

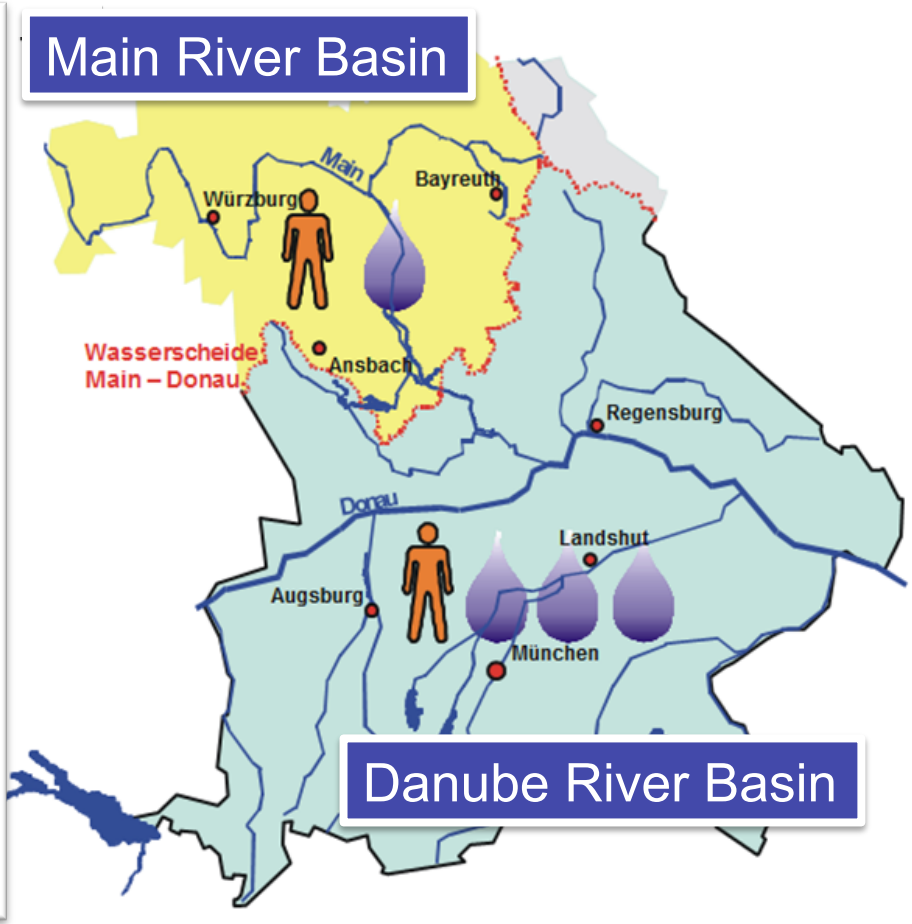
Based on LAWA-Guidance



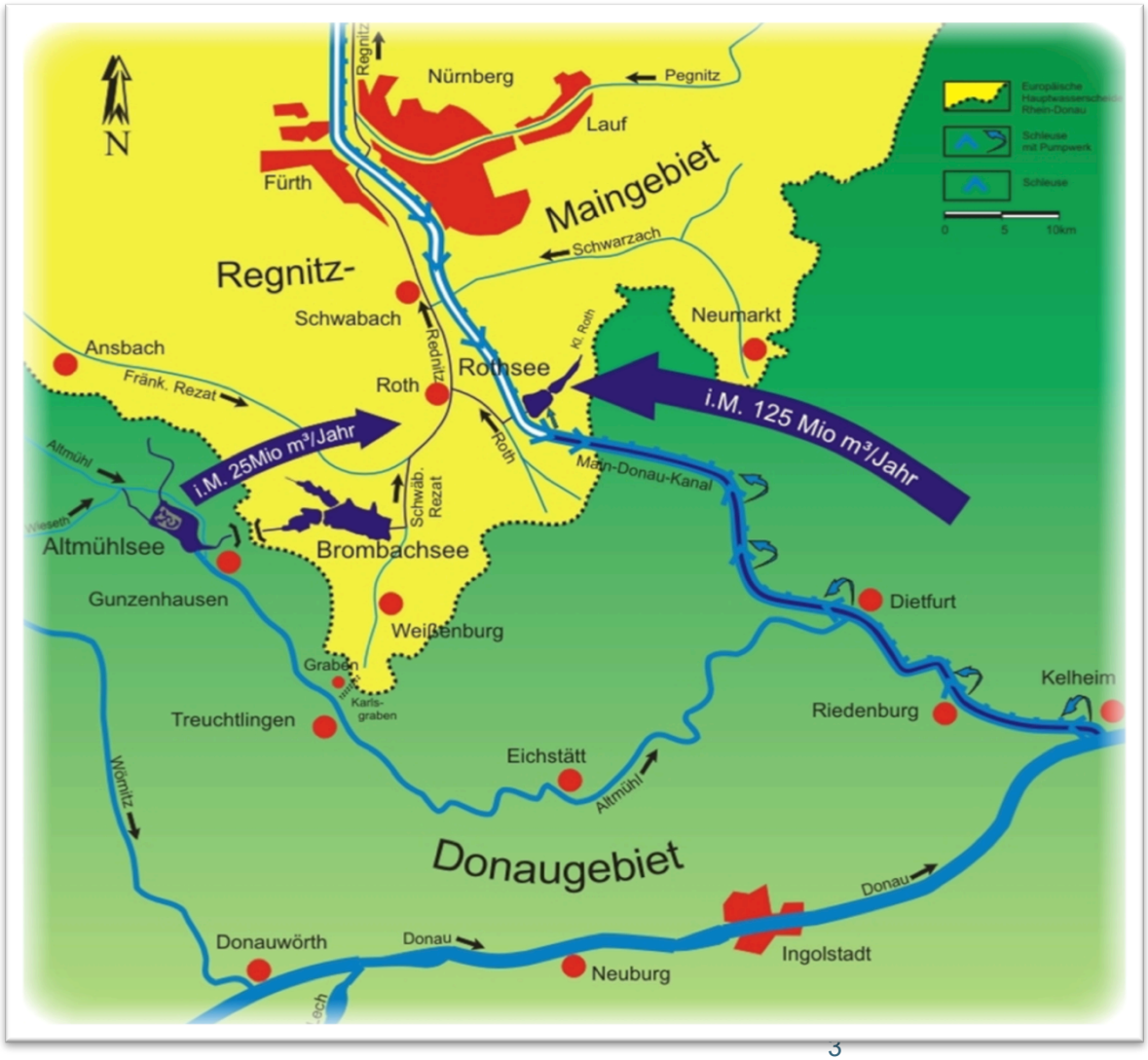
Hydrology of Bavaria



Yearly Precipitation



Danube - Main River Water Transfer System



Danube -Main Canal

Length 171 km

Maximum water transfer capacity: 150 million m^3 per year

Three reservoirs: storage capacity 180 million m^3

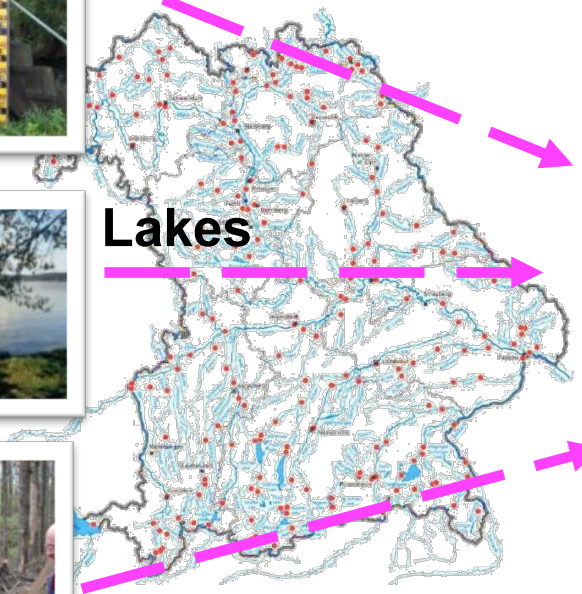
1 Low Water Information Service on Internet

State monitoring networks for quantitative hydrology

Rivers

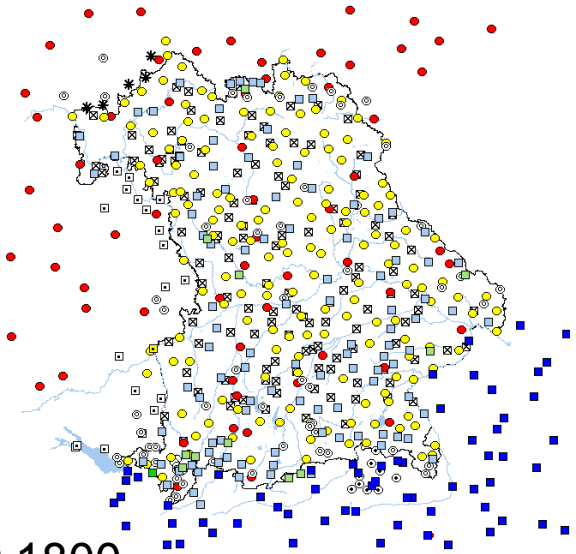
Lakes

Groundwater



Database-Server

Meteorology, Precipitation



Remote data transmission at about 1800 stations of over 500 million data sets per year

Low Water Information Service on Internet

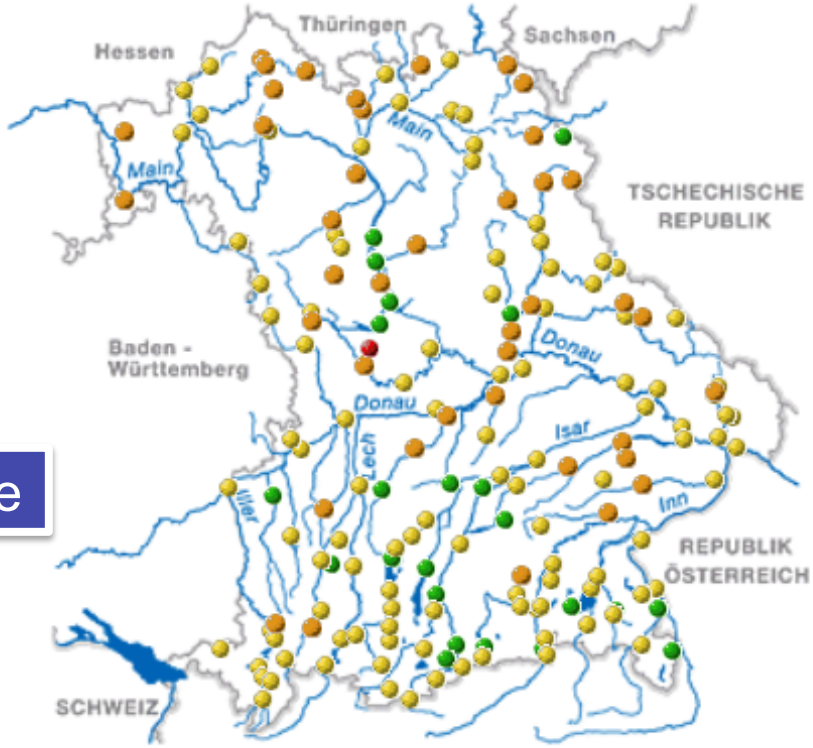
Niedrigwasser-Informationsdienst Bayern

Lage | Abfluss | Niederschlag | Wassertemperatur | Grundwasser | Seen/Speicher | Gewässerqualität | Ereignisse | Hilfe | Links

Niedrigwassersituation

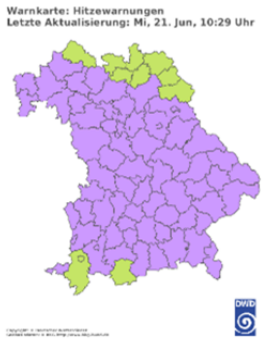
Hier Region wählen

www.nid.bayern.de



Abfluss: neuer Niedrigstwert | sehr niedrig | niedrig | kein Niedrigwasser

Hitzewarnungen DWD



Niederschlagsindex (90 Tage)

Low Water Status Report

1. Weather conditions: …
2. Rivers: …
3. Lakes and reservoirs: …
4. Groundwater levels: …
5. Water quality of rivers: …
6. Water quality of lakes:…
7. Outlook: …

Further Information:
http://www.nid.bayern.de

Niedrigwasser-Lagebericht Bayern

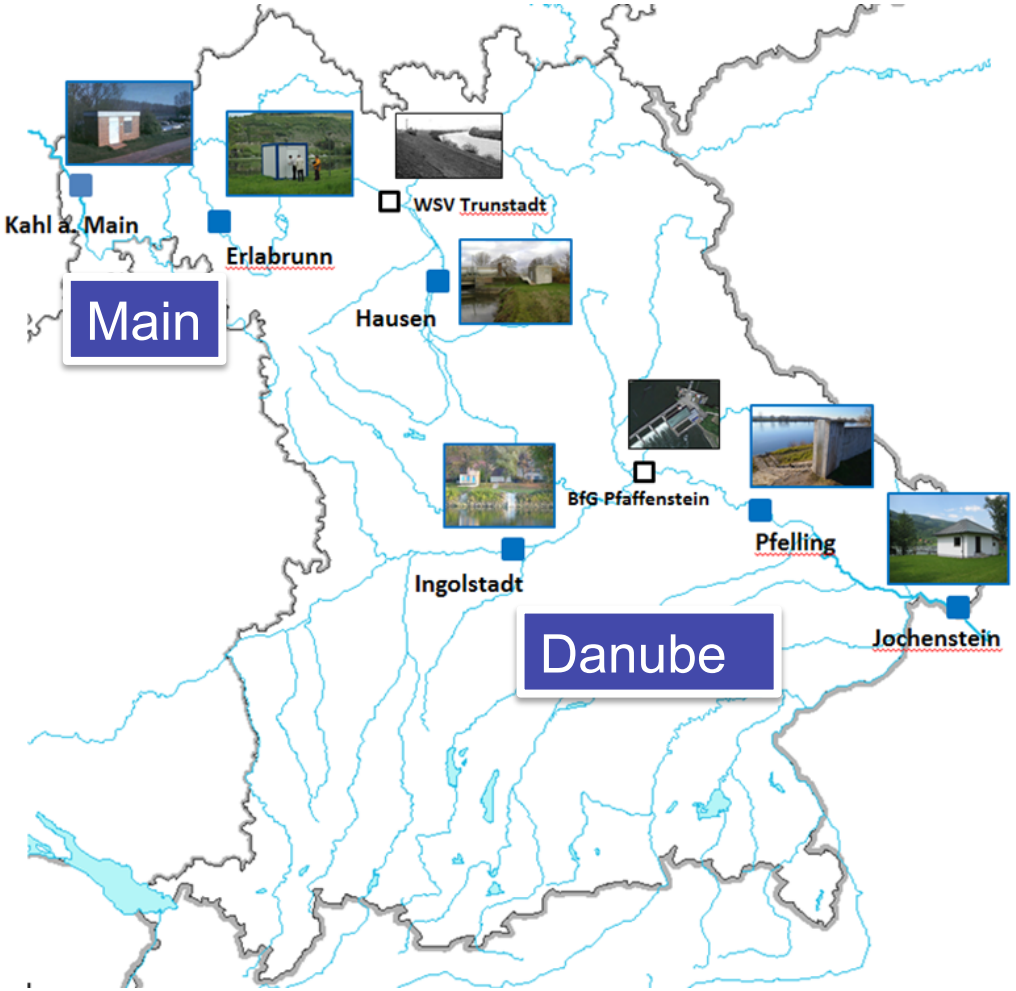
Bericht Nr. 65 vom 27.07.15, 15:45 Uhr

Insbesondere nördlich der Donau und in Niederbayern nach wie vor sehr niedrige Grundwasserstände und niedrige Abflüsse bei den Fließgewässern.

1. **Witterung: ...**
2. **Fließgewässer: ...**
3. **Speicher und Seen: ...**
4. **Grundwasserstände: ...**
5. **Wasserqualität Fließgewässer: ...**
6. **Wasserqualität Seen: ...**
7. **Ausblick:**

Laut Vorhersagen des Deutschen Wetterdienstes herrscht in den nächsten Tagen eine Westwetterlage mit zeitweiligen Regen- schauern. Die für Nordbayern vorhergesagten Flächen- niederschläge sind aber gering und dadurch wird sich die Niedrigwassersituation weiter fortsetzen. Aufgrund der zwischenzeitig deutlich gestiegenen Sauerstoffgehalte im unteren bayerischen Mainabschnitt sind gegenwärtig keine negativen Auswirkungen auf die Gewässerökologie, wie etwa auf Fische oder Makrozoobenthos zu erwarten.

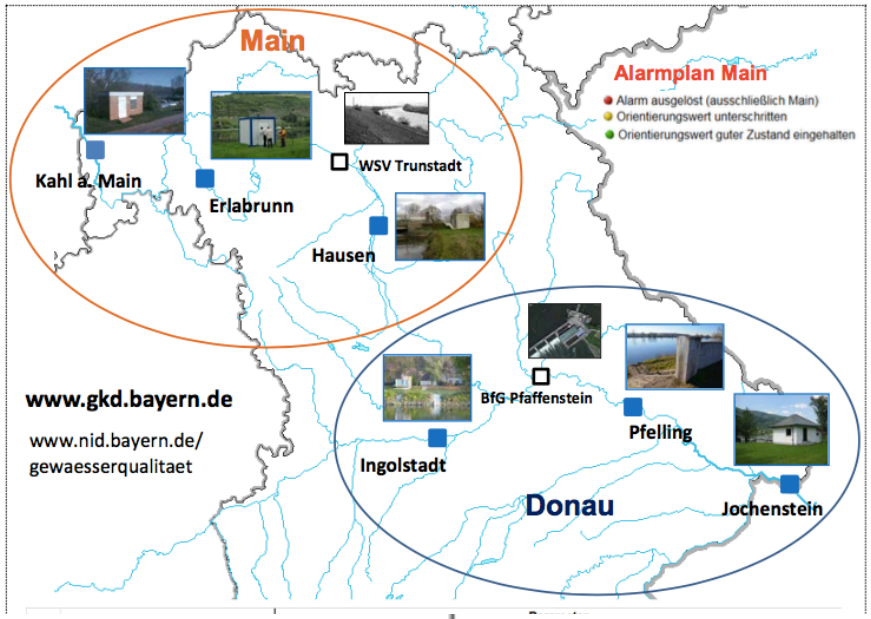
2 Ecological Warn and Alarm Plans for Main and Danube



Aims:

- Detect critical situations for river ecology in an early state
- Inform and raise attention of water users and the public
- Start mitigation measures to protect river ecology.

Ecological Warn and Alarm Plans

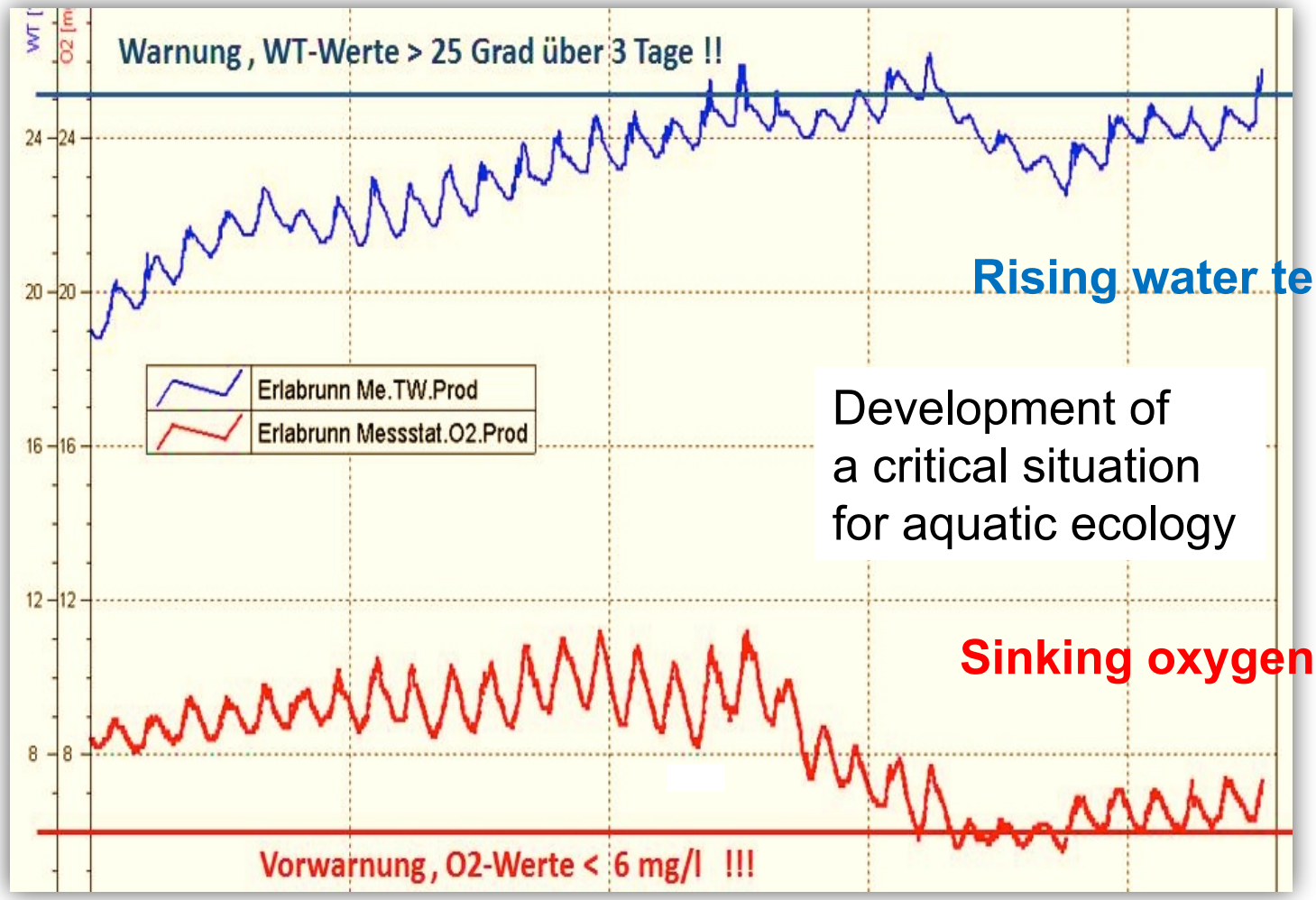


Automatic monitoring of water quality

Monitoring parameters

		Parameter								
	Name	Sauerstoff	pH	Leitfähigkeit	Wassertemperatur	Nitrat-N	Ammonium-N	Orthophosphat	Trübung	Chlorophyll a
GKD	Messstation Kahl a. Main (Verlegung)	X	X	X	X	X	X	X	X	X
GKD	Messstation Erlabrunn	X	X	X	X	X			X	X
GKD	Messstation Hausen	X	X	X	X	X	X	X	X	X
GKD	Messstation Ingolstadt/Luitpoldstraße	X	X	X	X			?		
GKD	Messstation Pfelling (Aufbau)	X	X	X	X	X	X	X	X	X
GKD	Messstation Jochenstein	X	X	X	X	X	X	X	X	X
WSV	Messstation Trunstadt				X					
BfG	Messstation Pfaffenstein	X	X	X	X					
		X	geplante Sondenausstattung			?	Sondenausstattung Cycle-P-Sonde im Test			

Ecological Warn and Alarm Plans



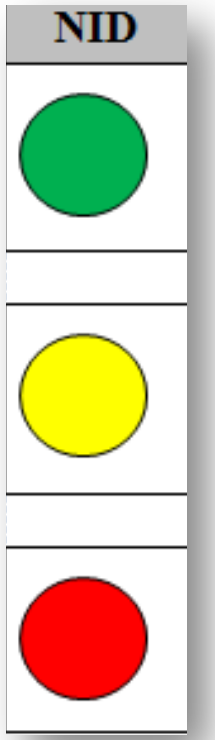
Rising water temperature

Development of
a critical situation
for aquatic ecology

Sinking oxygen concentration

Ecological Warn and Alarm Plans

Levels of alert

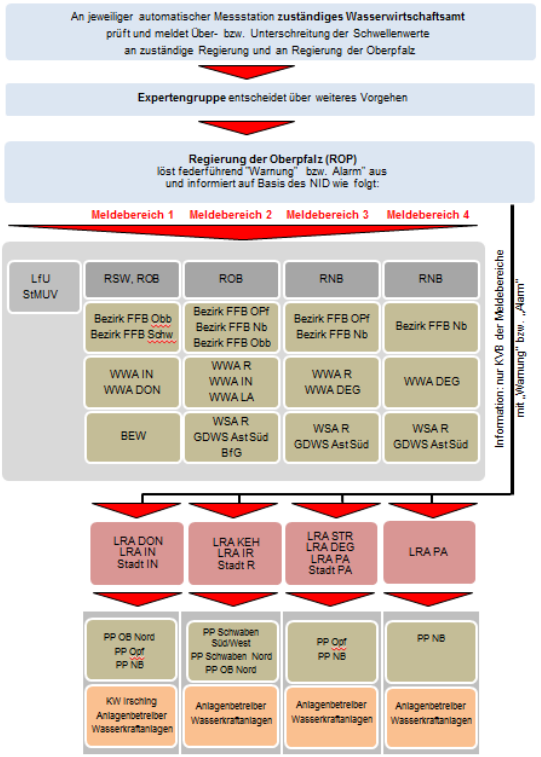


Pre-warning
Critical conditions are to be awaited in next time

Warning
A critical situation for water biology has occurred

Alarm
Significant impairment of aquatic biology including fish fauna is to be expected

Reporting chain



Ecological Warn and Alarm Plans

Three levels of alert defined by threshold values for two control parameter:

- water temperature (WT)
- oxygen concentration in water (O_2)

Threshold values

Meldebereich	DONAU	NID
	Vorwarnung	
1, 2, 3	WT ≥ 25,0 °C oder O_2 ≤ 7 mg/l	
4	WT ≥ 23,0 °C oder O_2 ≤ 7 mg/l	
	Warnung	
1, 2, 3	WT > 25,0 °C an 3 Folgetagen oder WT ≥ 26,0 °C oder O_2 ≤ 6 mg/l	
4	WT > 23,0 °C an 3 Folgetagen oder WT ≥ 26,0 °C oder O_2 ≤ 6 mg/l	
	Alarm	
1, 2, 3, 4	WT ≥ 27,0 °C oder O_2 ≤ 5 mg/l	

Ecological Warn and Alarm Plans – Information and Measures

Three levels of alert

1 Pre-warning

Information of water authorities and other operators of monitoring stations.

Measures: Inspection of monitoring stations; screening for sources of pressures.

2 Warning

Warning messages to concerned state and local authorities, police, municipalities, large discharger like sewage stations, industrial plants and the media.

Measures: Intensified monitoring and biological sampling in the rivers; communication with discharger to avoid any measures, which could worsen the situation and take measures to reduce the impact on water biology.

3 Alarm

Alarm messages like for warnings.

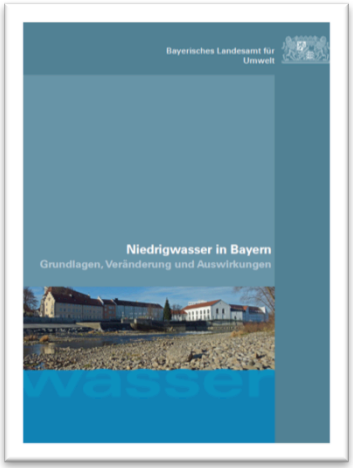
Measures: Aeration of water by turbines; extended water transfer by the Danube-Main system; deployment of aide assistance by police, firefighters and others; restrictions for water uses by decree of the water authority.

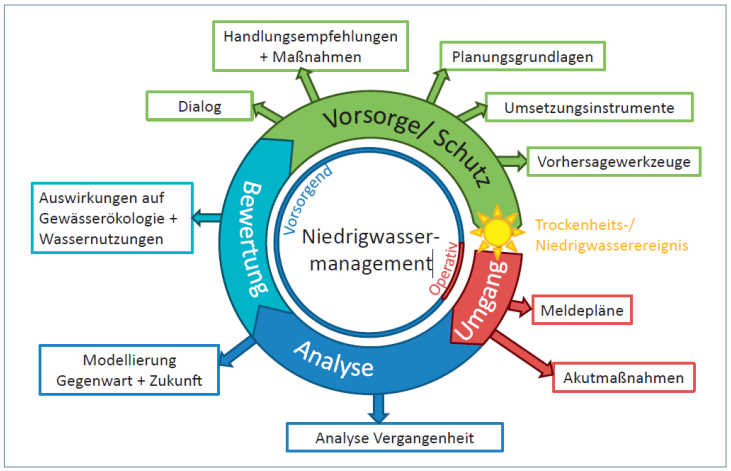
1 LAWA-Guidelines for Low Water Management 2007

1 Low water precaution
planning ahead in order to minimize development and impact of low water events

2 Low water management
operational measures during low flow events in order to minimize damage of low water events

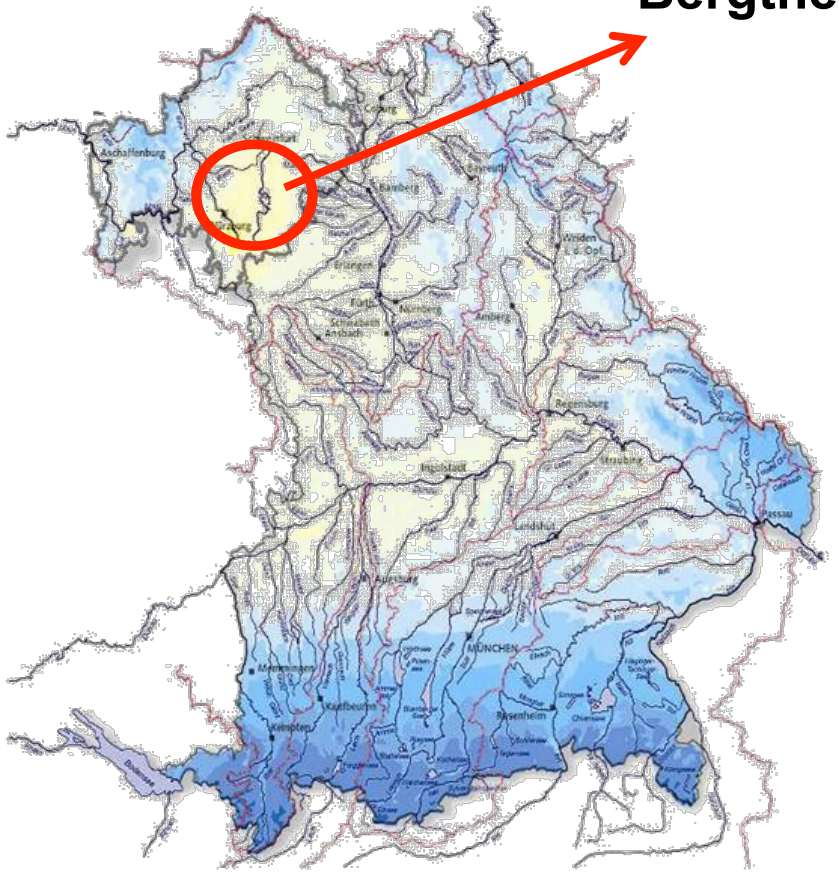
2 Low Water Report Bavaria 2016





Management Circle of Low-Flow

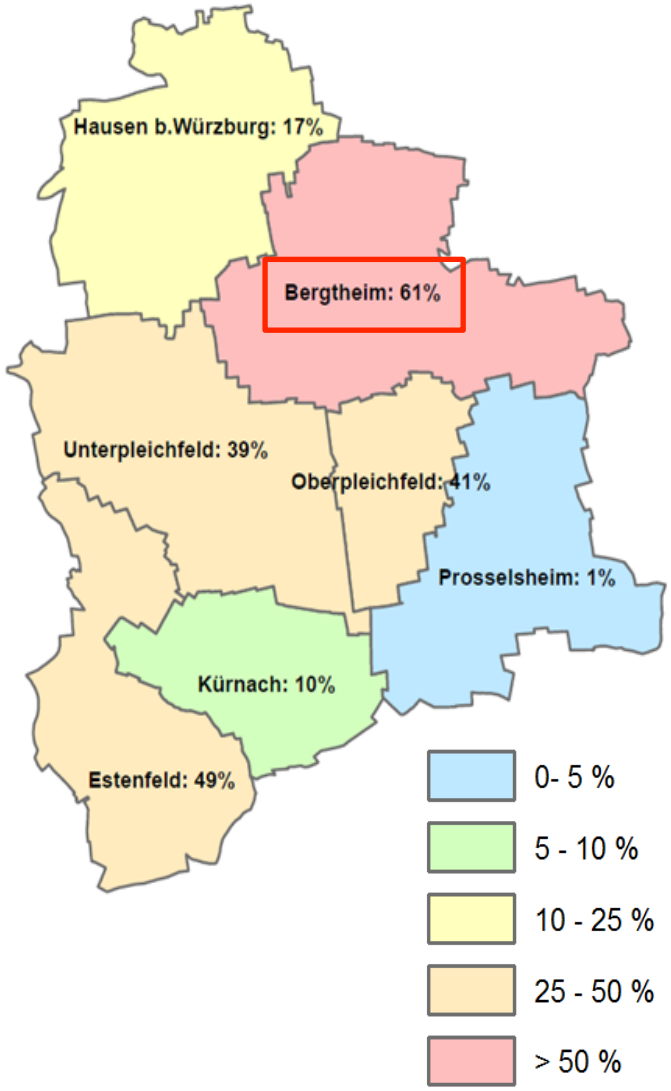
3 Low Water Management – Pilot Project Bergtheim



Water demand for irrigation

Sheeting with drop irrigation

Low Water Management – Pilot Project Bergtheim



- Irrigation for vegetable farming
- Intensive irrigation with groundwater
- 50 % of productive land is irrigated
- Drip irrigation
- 30 mm groundwater recharge per year
- Evidence of overuse of water resources
- Irrigation rival to public water supply.

Ratio of licensed water abstraction
to average yearly groundwater recharge:

Low Water Management - Pilot Project Bergtheim

Analysis

- A lack of data on water use and water resources for planning
- Operational measures saving irrigation water are very limited
- Technical measures saving irrigation water are very limited
- Provision of new water resources (reservoirs) requires high investments

Preliminary Recommendations

- Improve data basis for management by establishing a central data base
- **Establish Irrigation associations** of farmers for self-management of water allocation, operation and maintenance of installations
- Long-term precautionary measures are preferential
- Public water supply is prior-ranking to private water use for irrigation

Low Water Management - Pilot Project Bergtheim

Risk classes of water abstraction for irrigation

Preliminary risk assessment and classification by
(1) spatial extension of irrigated land and (2) groundwater balance

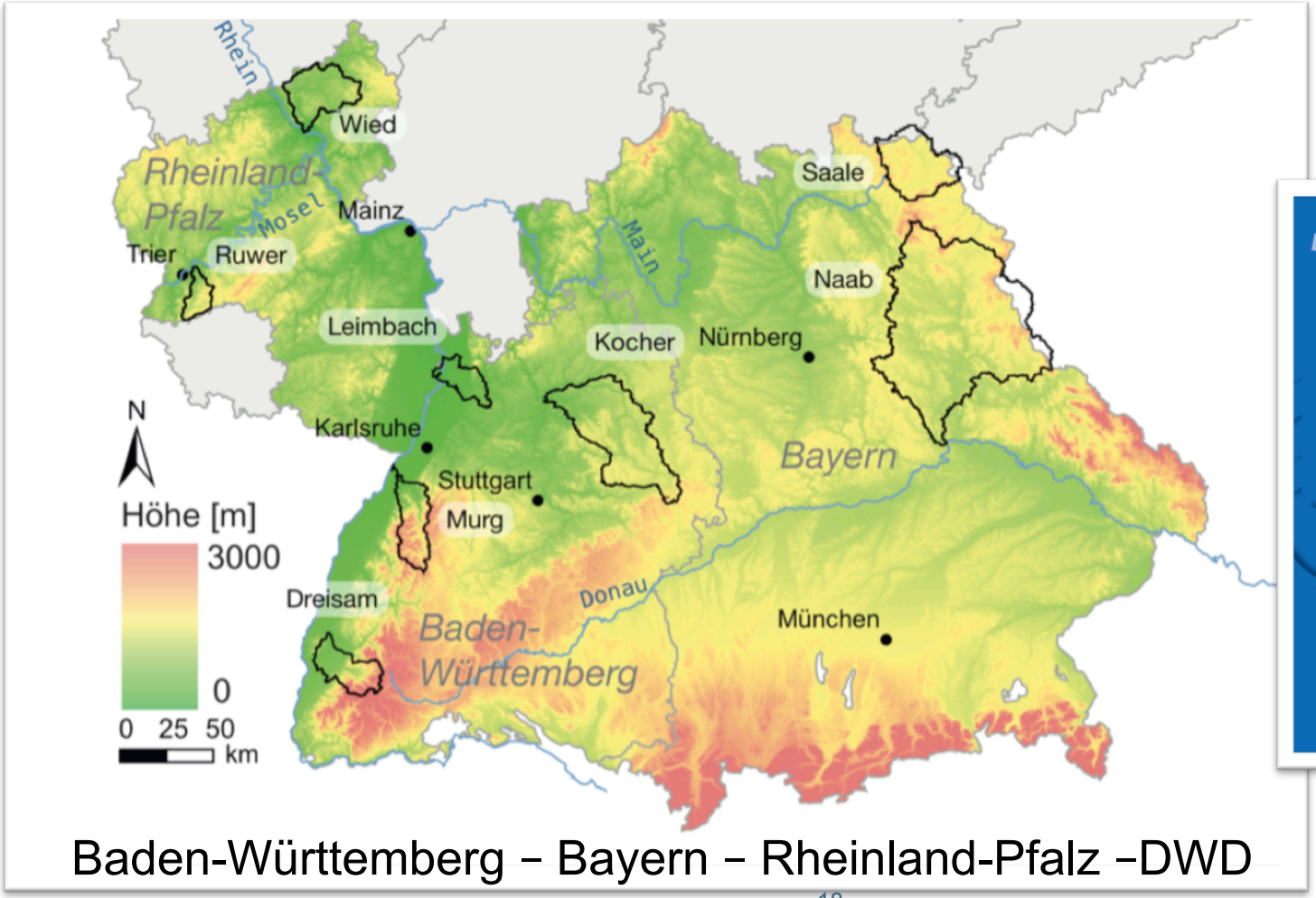
Area irrig.	= Kreisradius	Ratio of water abstraction to groundwater recovery									
		Ergebnis Wasserbilanz bis zu [%]*									
bis…. [ha]	[m]	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
10	178										
50	399										
100	564										
500	1.262										
1.000	1.784										
2.500	2.821										
5.000	3.989										
10.000	5.642										
25.000	8.921										
50.000	12.616										

Risiko/Prüftiefe:
gering
mittel
hoch
sehr hoch

4 KLIWA – Low Flow Case Studies

KLIWA Klimaveränderung und Wasserwirtschaft

KLIWA (Climate Change and Water) – Eight low flow case studies



Baden-Württemberg – Bayern – Rheinland-Pfalz –DWD

www.kliwa.de

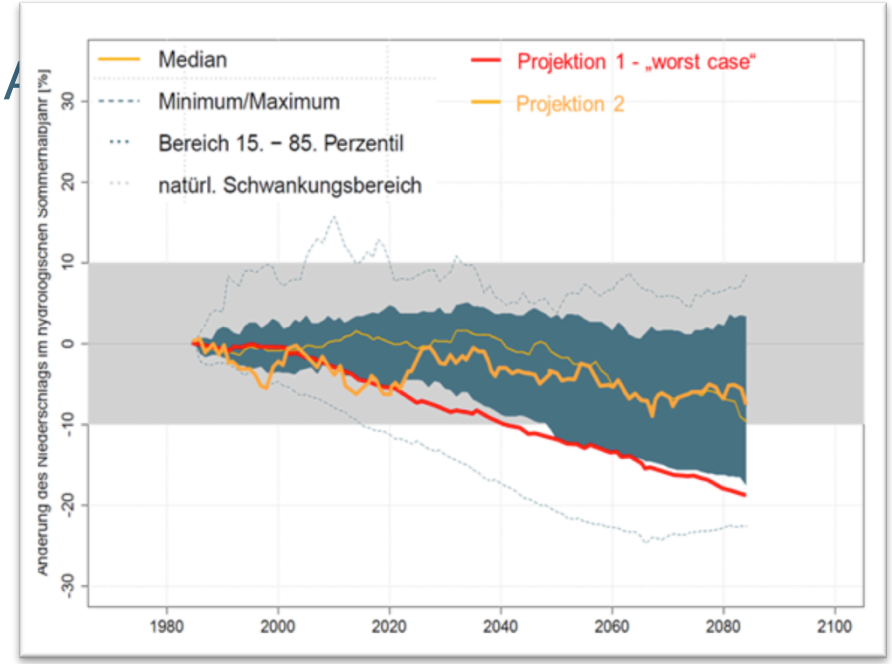
KLIWA – Low Flow Case Studies

Two case studies at the rivers **Naab** and **Sächsische Saale** in 2015/16.

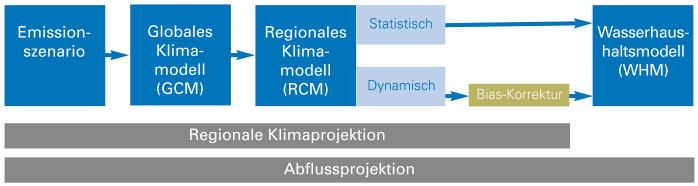
Topics of low water management:

- **Reservoir management**
- Fish farming
- Hydropower
- Sewage discharge
- Ecological minimum flows

KLIWA – Low Flow Case Studies



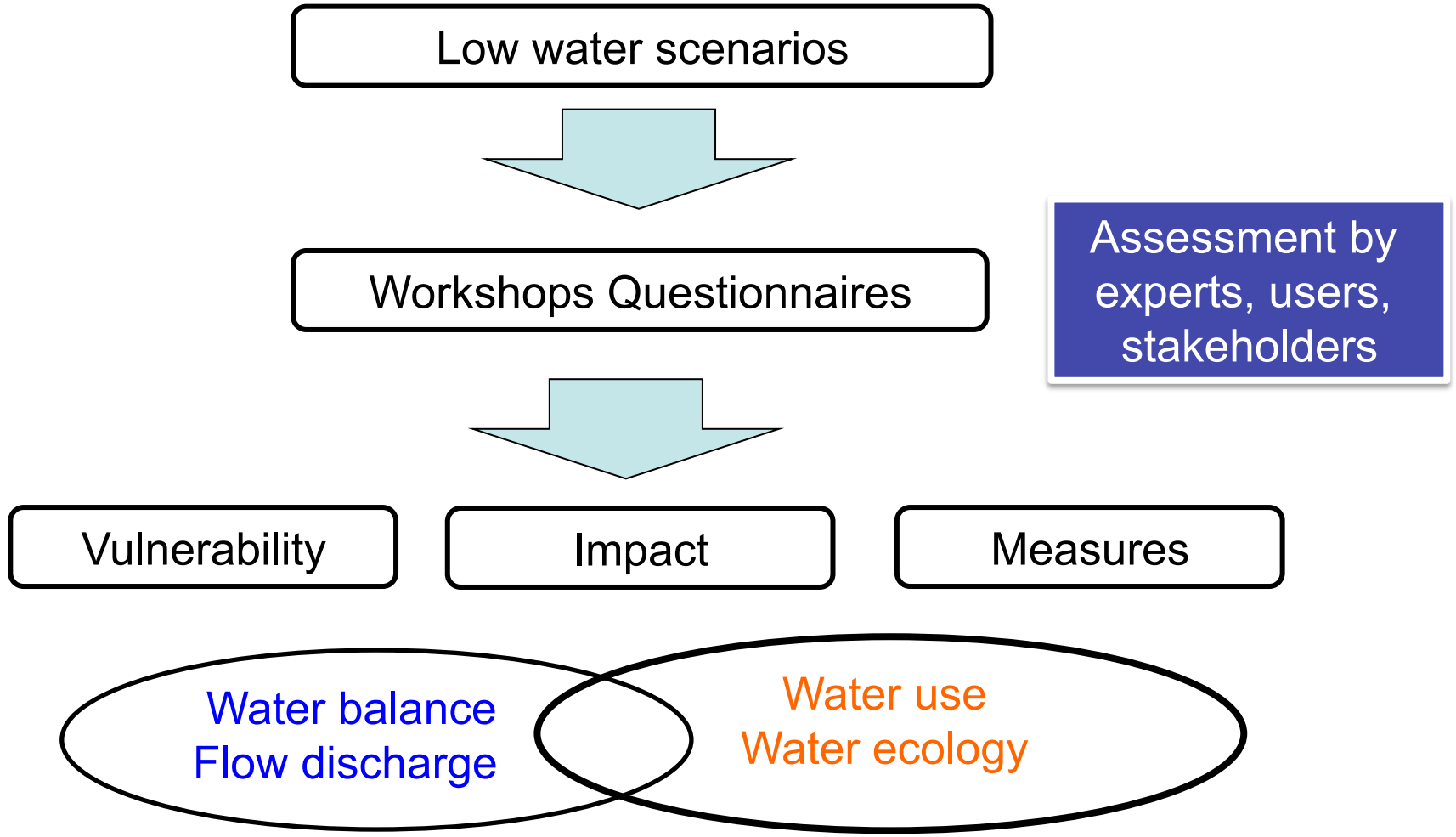
Jahr	Basis (hyd. Jahr)	Ausprägung	Jahr	Basis (hyd. Jahr)	Ausprägung
1	1992	Normaljahr	11	1988	Feuchter Winter
2	2003	Trockenjahr	12	1992	Normaljahr
3	2003	Trockenjahr	13	1976	Trockener Sommer
4	2003	Trockenjahr	14	1992	Normaljahr
5	1992	Normaljahr	15	1996/2003	Tr. Winter / Tr. Sommer
6	1992	Normaljahr	16	1996/2003	Tr. Winter / Tr. Sommer
7	2003	Trockenjahr	17	1996/2003	Tr. Winter / Tr. Sommer
8	1998	Feuchter Sommer	18	1992	Normaljahr
9	2003	Trockenjahr	19	1992	Normaljahr
10	1988	Feuchter Winter	20	1988	Feuchter Winter



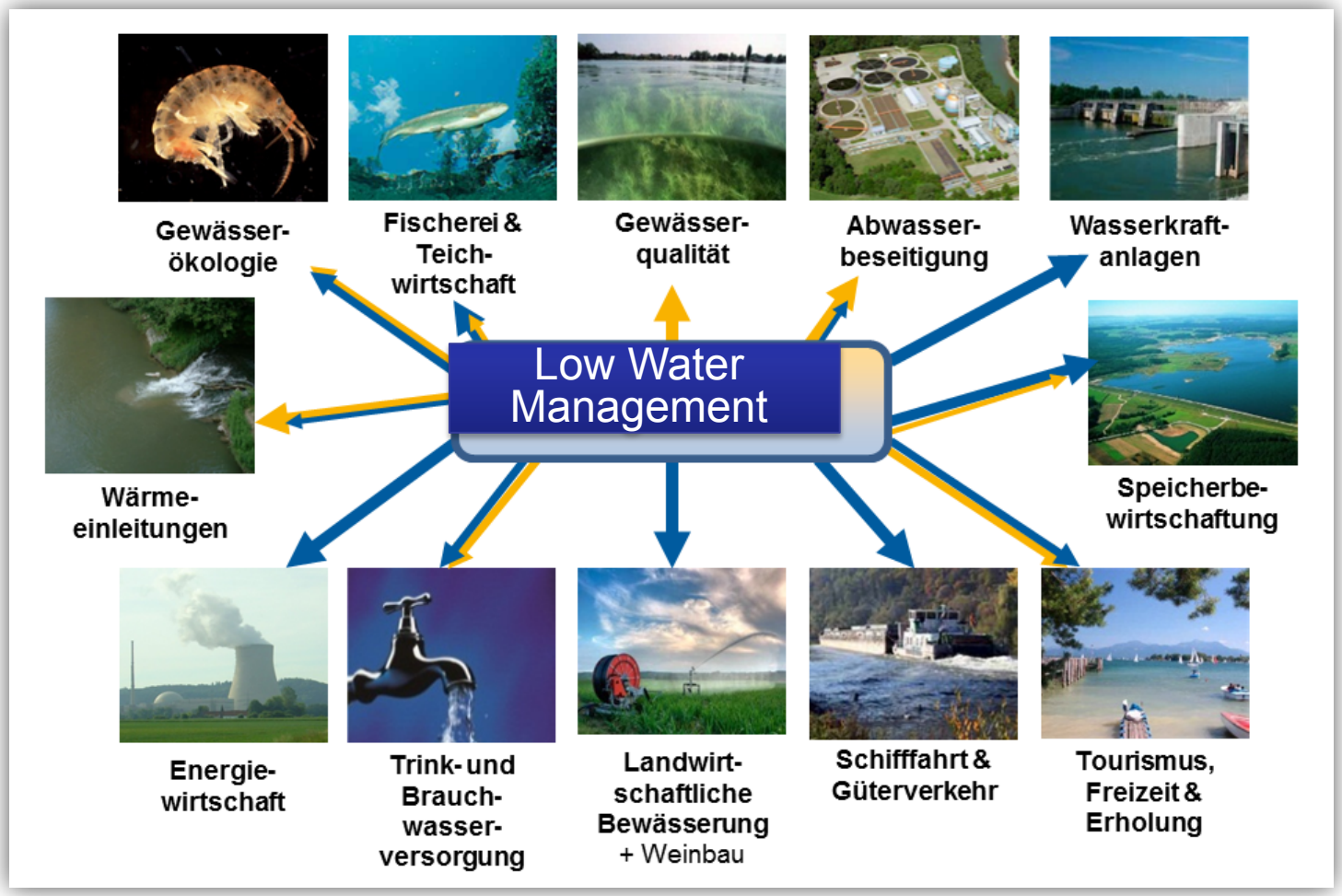
<u>Scenario type 1:</u>
Model-based scenarios derived from ensembles of projections resulting from numeric climate models in combination with water balance models

<u>Scenario type 2:</u>
Heuristic scenarios designed from a artificially build sequence of chosen historical records of dry years.

KLIWA – Low Flow Case Studies



Complexity of Low Water Management



Quantitative Impact Qualitative Impact

Complexity of Low Water Management

Low water management has to deal with

- *Surface water and groundwater*
- *Water use and water ecology*
- *Water quantity and quality*
- *Supply and demand of water*
- *Precaution and operation*
- *Measures of monitoring and information, engineering, ecology and economics, administration and legislation.*