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GROW

WATER AS A GLOBAL RESOURCE



REDUCING THE WATER FOOTPRINT OF THE GLOBAL COTTON-TEXTILE INDUSTRY TOWARDS THE UN-SDGs

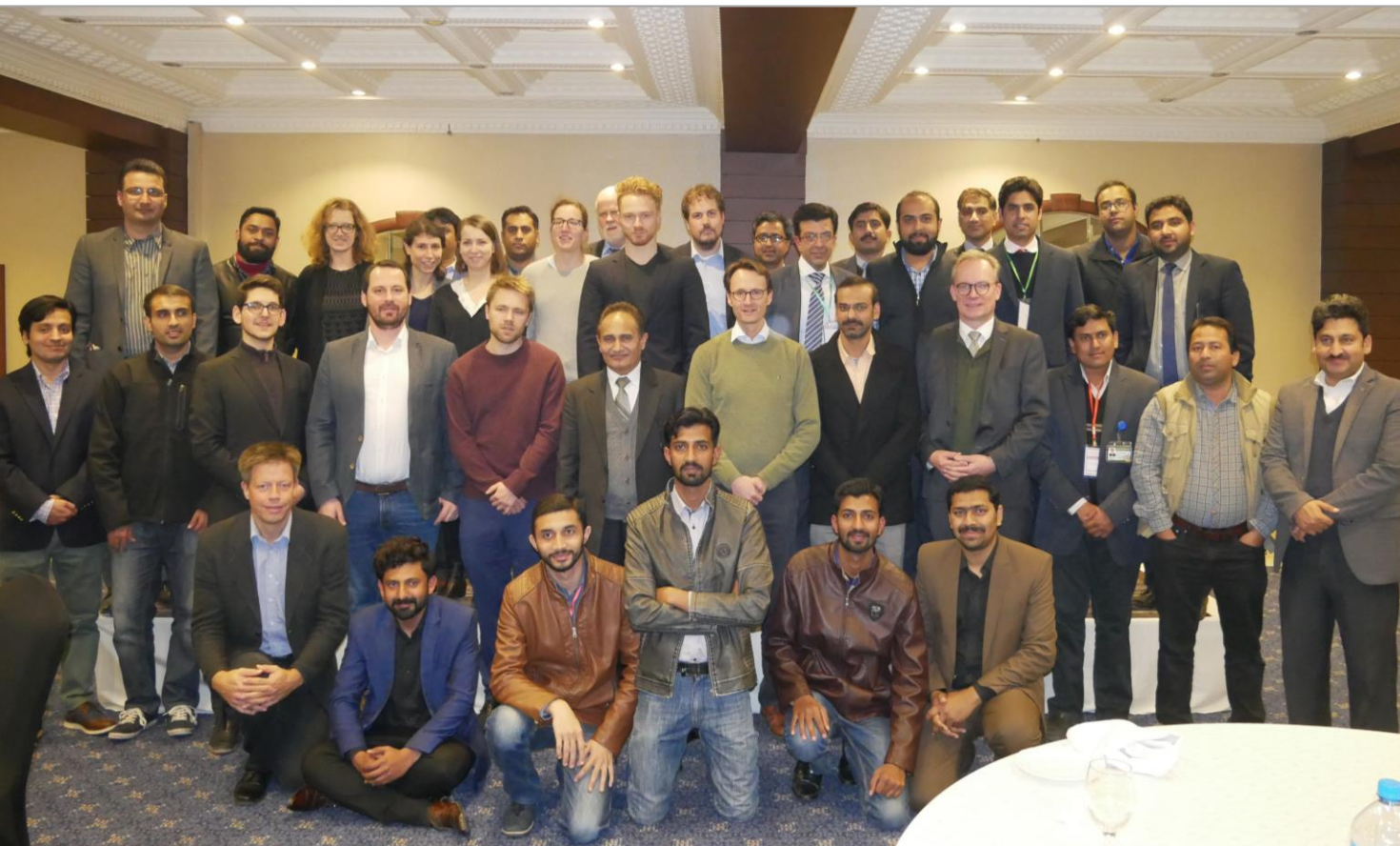
**Dr. Frank-Andreas Weber (FiW)
and InoCottonGROW Project Team**
February 20th, 2019

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MID-TERM CONFERENCE AT UNIVERSITY OF AGRICULTURE, FAISALABAD



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Invitation to
Mid-Term Conference

**Water Footprints of the
Cotton-Textile Value
Chain: Environmental
Repercussions from Field to
Hanger**

January 29 to February 02, 2019

VENUE
New Senate Hall
University of Agriculture Faisalabad

Jointly Organized by
Faculty of Agricultural Engineering & Technology,
UNIVERSITY OF AGRICULTURE FAISALABAD &
BMBF-InoCottonGROW Project Partners





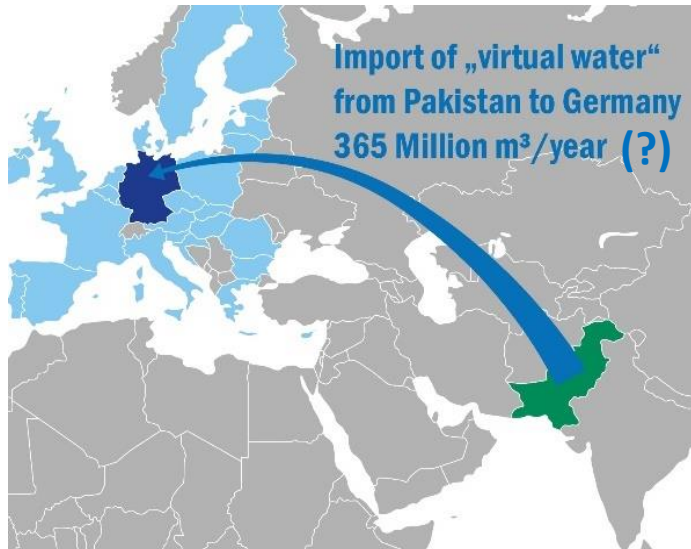
COOPERATION PARTNERS



Punjab Irrigation & Drainage Authority



COTTON-TEXTILE VALUE CHAIN



	Germany	Pakistan
Population	82 million	208 million
Cotton Production	-	1.8 million tons
People employed in Cotton Textile-Retailing Value Chain	94'000	> 25 million
Import of Textiles and Clothing	42 Billion EUR (1.3 Billion EUR directly from Pakistan)	
Turnover of Textile Retailing Business	63 Billion EUR	-

UN-SDG 6 “Clean Water and Sanitation” and related Targets in 2015 (UN-STAT 2018, <https://unstats.un.org/sdgs/>)

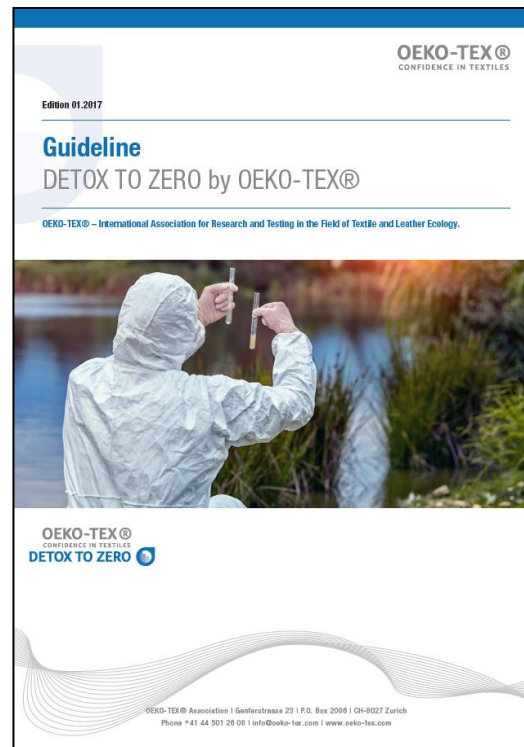
6.1.1 Population using safely managed drinking water	99.2 %	35.6 %
6.3.2 River water bodies with good ambient water quality	35.1 %	No data
6.4.2 Level of water stress	41.5 %	102.5 %
3.9.2 Mortality due to unsafe water and sanitation per 100,000 population	0.6	19.6
2.1.1 Prevalence of undernourishment	<2.5%	19.9%

WASTEWATER TREATMENT AND WATER QUALITY

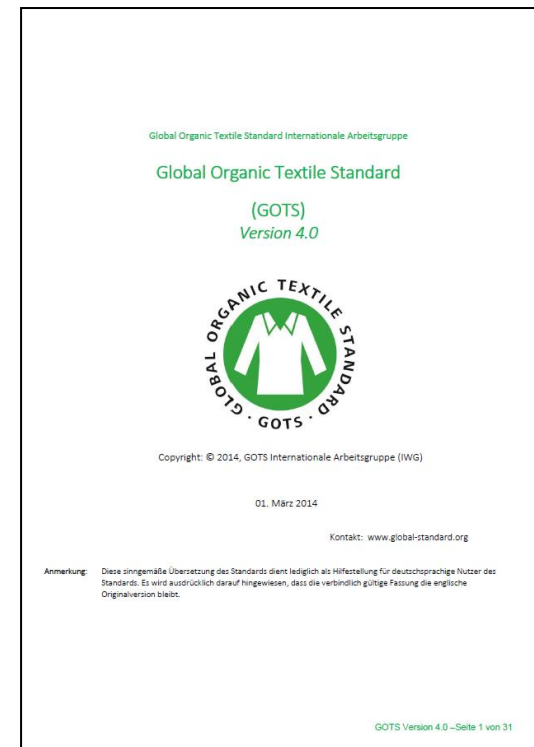
Due to public pressure, brands are increasingly demanding their producers to comply with environmental standards.



ZDHC (2016)



OEKO-TEX (2017)



GOTS (2014)







PROJECT GOALS

1. **Make the water footprint** a meaningful steering indicator for decision-makers, retailers & consumers
2. **How water-intensive is the Cotton-Textile Value Chain really?**
From inventory analysis to impact assessment in Punjab
3. **How to improve:** Five demonstration projects
4. **Scenarios:** consistent options for intervention given the current economic and institutional framework
5. Contribution towards **UN-Sustainable Development Goals**
6. Support **German retailers & consumers** in sustainable consumption

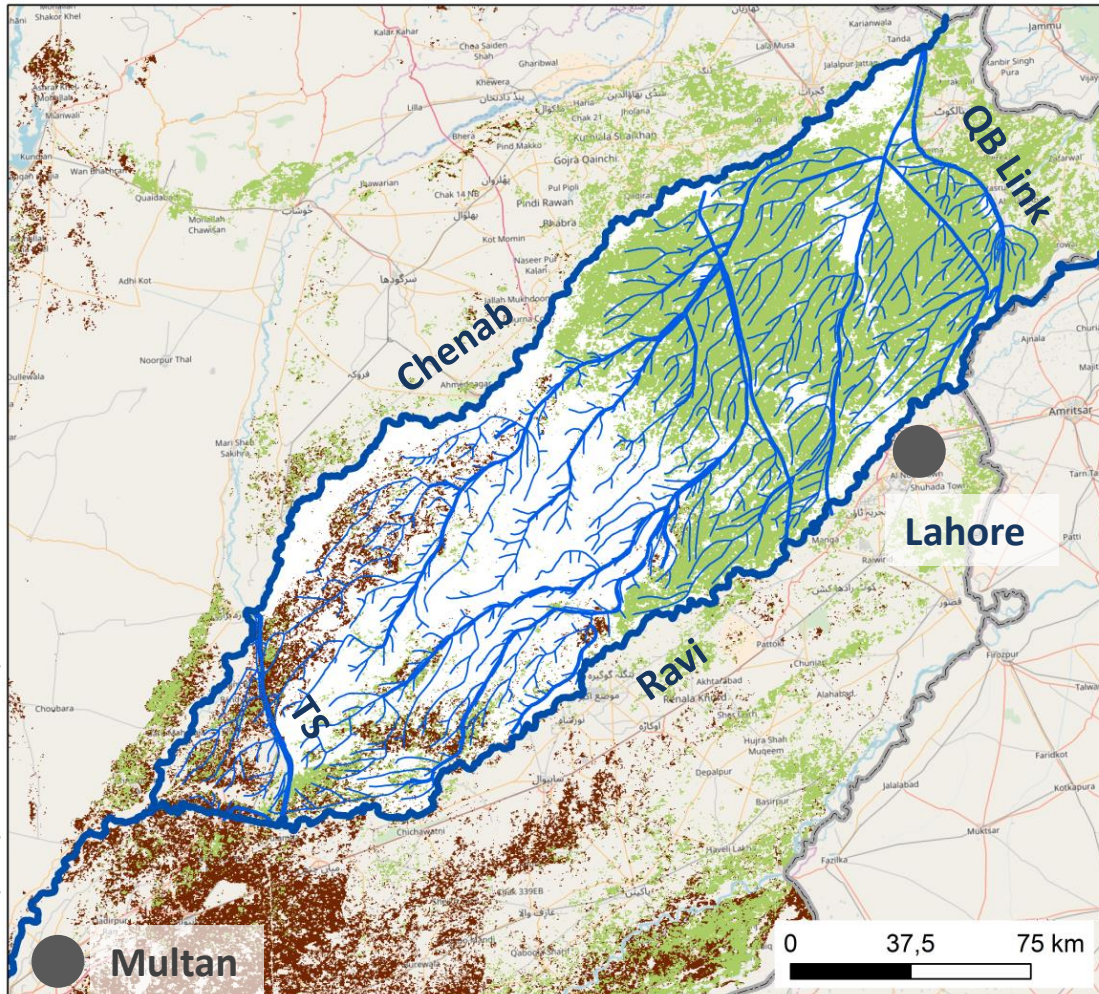
WATER FOOTPRINT AS A STEERING INDICATOR

Water Footprint Methodology			Policy Scenarios	
<p>Inventory Analysis</p>	<p>Impact Assessment: Cause-Effect Chains</p> <div style="border: 1px dashed black; padding: 5px;"> <p>Human Health</p> <ul style="list-style-type: none"> Water Scarcity Water Pollution </div> <div style="border: 1px dashed black; padding: 5px;"> <p>Ecosystem Damage</p> <ul style="list-style-type: none"> Water Scarcity Water Pollution </div>	<p>Options for WF Reduction</p> <p><u>Demonstrations:</u></p> <ol style="list-style-type: none"> 1. Advanced irrigation techniques & scheduling 2. Textile machinery 3. Advanced dyestuff 4. Wastewater treatment 5. Monitoring and pollution control 	<p>Intervention Strategies</p> <p><u>Scenarios:</u></p> <ol style="list-style-type: none"> 0. Business as Usual 1. Optimize the current system 2. Many pennies make a dollar 3. Think big 4. Regional shifting of water or crops 5. Quality instead of quantity 	<p>Contributing to UN-SDGs</p> <div style="background-color: #00AEEF; color: white; padding: 5px; text-align: center;"> <p>6 CLEAN WATER AND SANITATION</p> </div> <div style="background-color: #D49E00; color: white; padding: 5px; text-align: center;"> <p>2 ZERO HUNGER</p> </div> <div style="background-color: #2ECC71; color: white; padding: 5px; text-align: center;"> <p>3 GOOD HEALTH AND WELL-BEING</p> </div> <div style="background-color: #2ECC71; color: white; padding: 5px; text-align: center;"> <p>15 LIFE ON LAND</p> </div> <div style="background-color: #D49E00; color: white; padding: 5px; text-align: center;"> <p>12 RESPONSIBLE CONSUMPTION AND PRODUCTION</p> </div>

IMPACT ASSESSMENT: CAUSE-EFFECT CHAINS

	Water Scarcity	Water Pollution
Human Health	<p>(CE1) Impact of water scarcity on loss of yield and malnutrition</p>  <p>© FiW</p>	<p>(CE2) Impact of water pollution on drinking water quality</p>  <p>© FiW</p>
Ecosystem Damage	<p>(CE3) Impact of water scarcity on damage to freshwater ecosystems</p>  <p>Kalhor et al (2016): Kotri BarRage</p>	<p>(CE4) Impact on river water quality and toxicity to aquatic ecosystems</p>  <p>© FiW</p>

(M1) SATELLITE REMOTE SENSING



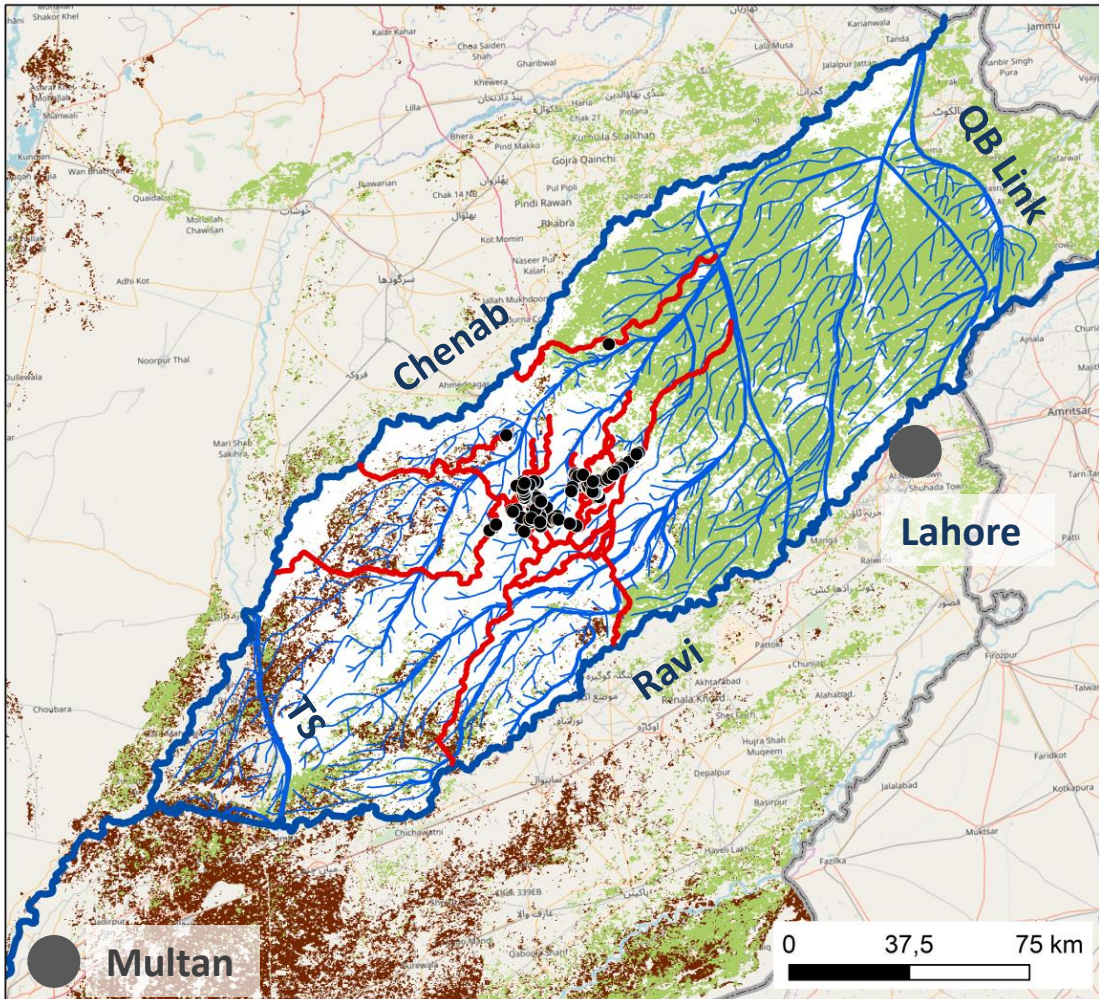
Land-Use Land-Cover Mapping (2005-2017)

- MODIS NDVI: 250 m resolution
- Sentinel 1 & 2: 20 m resolution
- Ground truthing: 1400 locations
- Both unsupervised and machine learning techniques

Cotton in Punjab province:
2.35 ± 0.21 million ha
 (47% of cultivated irrigated land)



(M6) TEXTILE MILLS AND WASTEWATER IN LCC AREA



- 85 Textile processing mills in larger Faisalabad, approx. 10 with installed wastewater treatment

— Central Drains



(M5) COTTON FARMERS IN WARABANDI SYSTEM

FACE-TO-FACE INTERVIEWS WITH 152 + 69 FARMERS

	Average	(Range)
Age	42	(19 - 80)
Schooling	10 years	(0 – 19)
Land ownership	2 ha	(0 – 40 ha)
Net income	1768 €/a	(177 - 42440 €/a)
Water shortage	70% experience water shortages (mainly April/May and winter)	
Water theft	26% complain when upstream farmers use more water than allowed in Warabandi system	
Raw Cotton Yield	2499 kg/ha ± 1500 kg/ha	
Groundwater abstraction in Kharif	184 mm ± 27 mm	



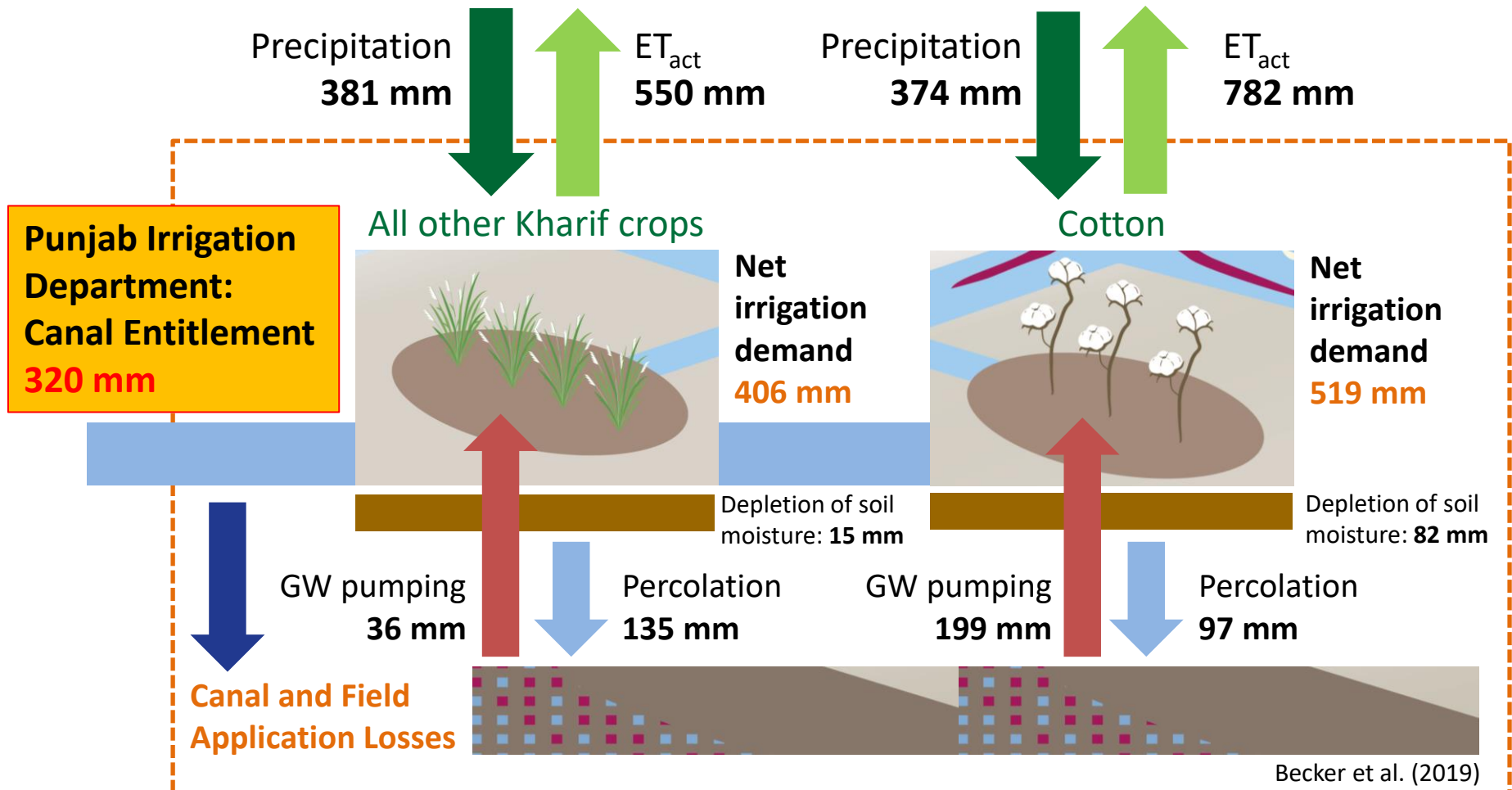
Photo: © FIW



Photo: © Zimmermann

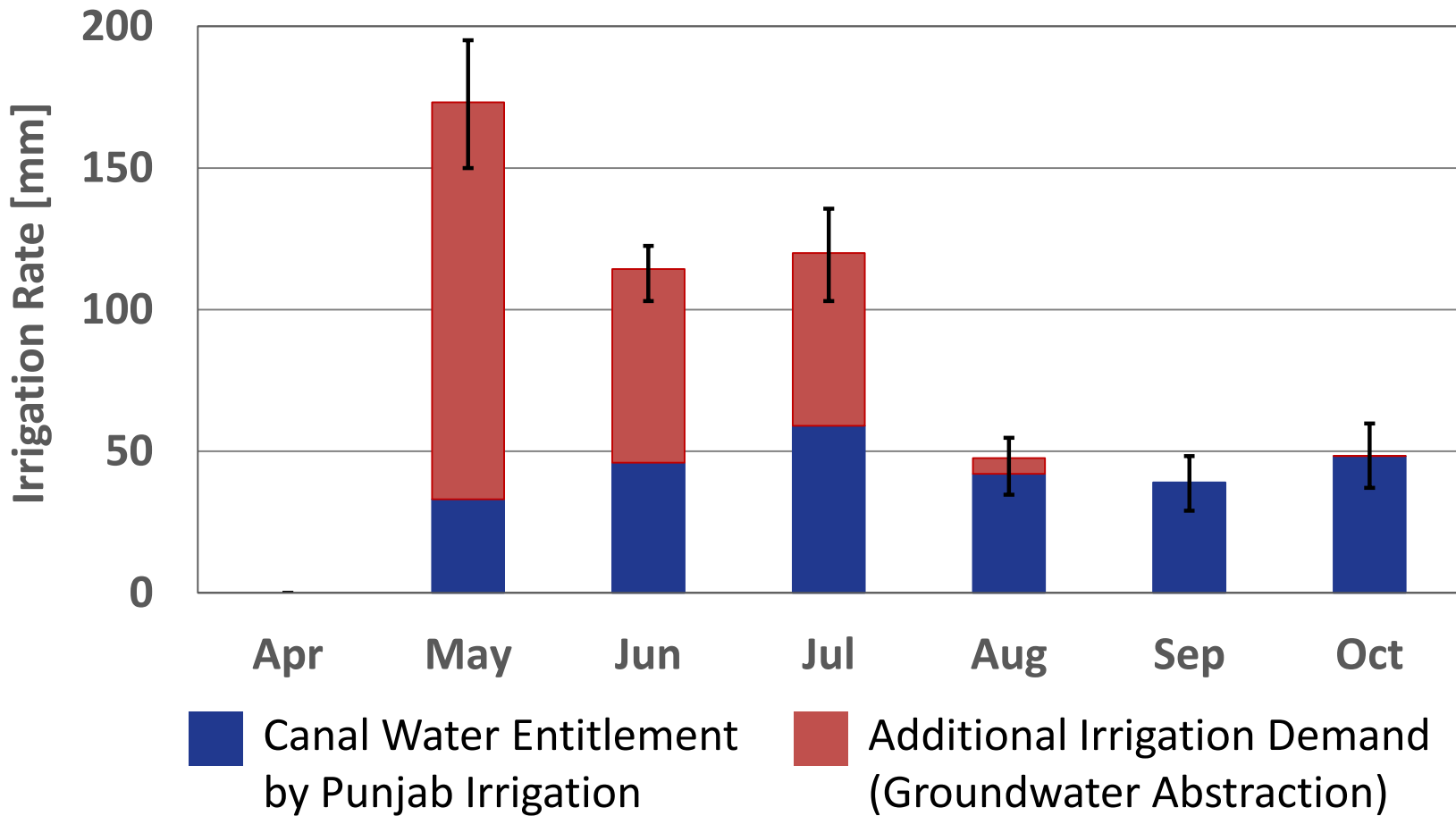
(M3) HYDROLOGIC SWAT MODEL IN LCC AREA

CROP IRRIGATION IN KHARIF SEASON (MEAN 2004-2013)

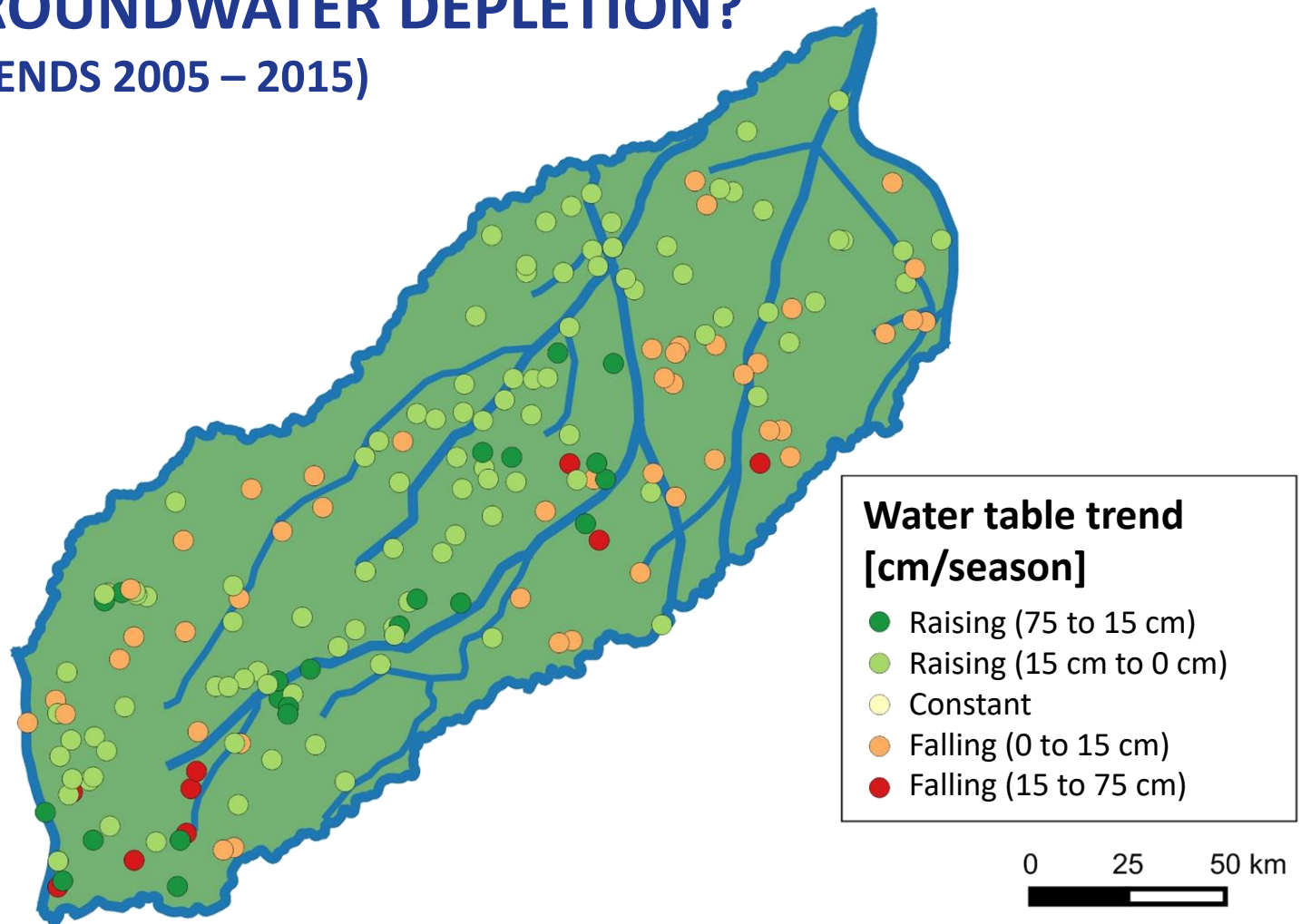




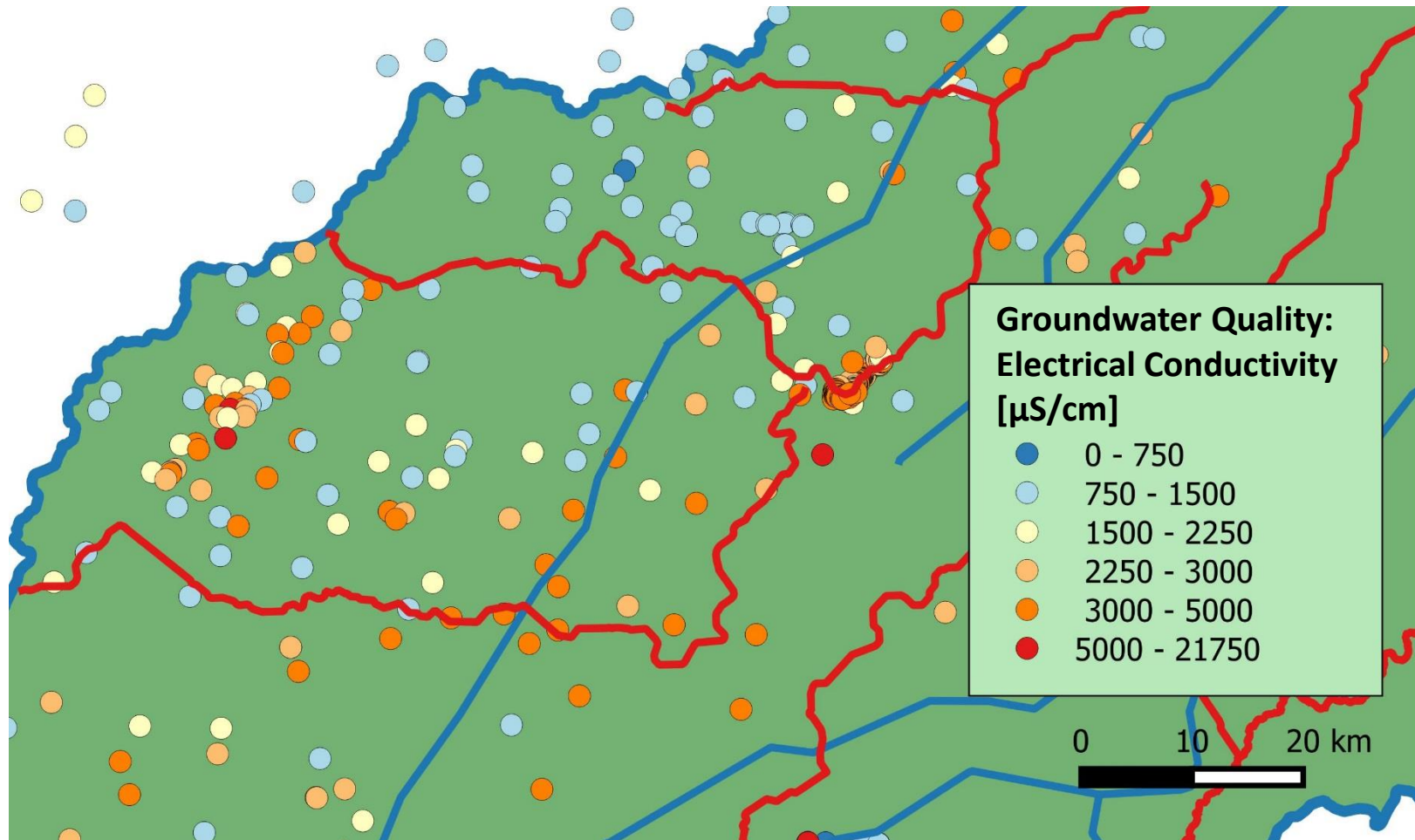
(M3) DEMAND FOR COTTON IRRIGATION



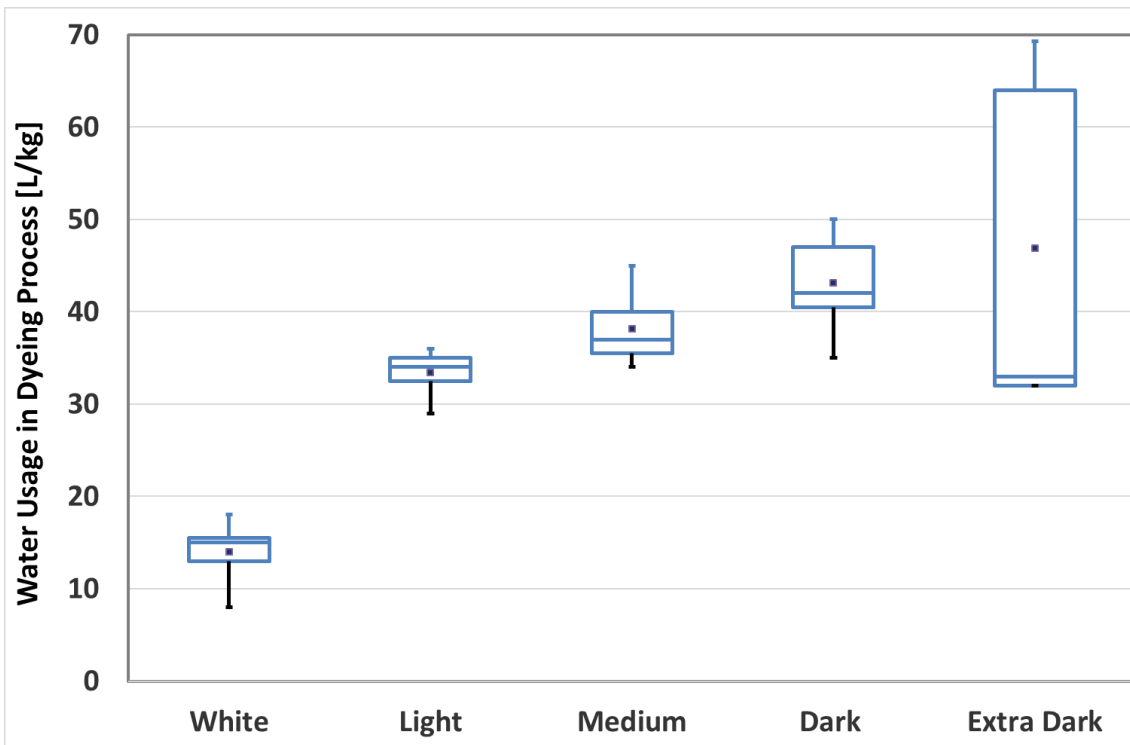
(M4) HYDRAULIC GROUNDWATER MODEL (FEFLOW) GROUNDWATER DEPLETION? (TRENDS 2005 – 2015)



(M4) GROUNDWATER QUALITY



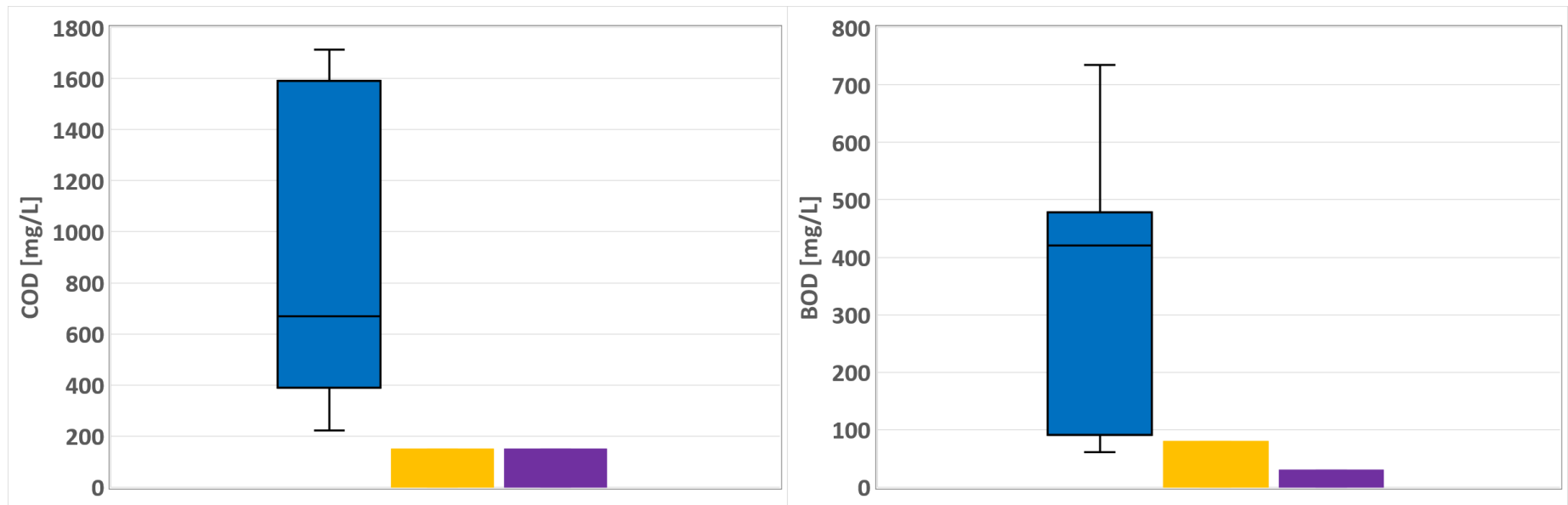
(M7) WATER USE OF EXHAUST DYEING MACHINERY THIES iMASTER OPERATED IN PAKISTAN (N=7-9)






Freericks, THIES (2018)

(M6) WASTEWATER OF TEXTILE PROCESSING PLANTS

RESULTS OF 9 COMPANY SURVEYS



-  Box-Plot of Wastewater Compositions (n=9)
-  Pakistan National Emission Standard
-  Zero Discharge of Hazardous Chemicals (ZDHC) - Foundational



Five Demonstration Projects: How to improve

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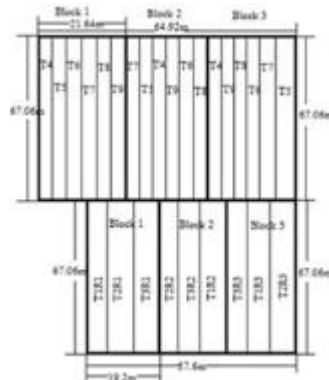
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(D1) IMPROVED WATER PRODUCTIVITY

	Yield [t/ha]	Efficiency	Productivity [kg raw cotton / m ³ gross irrigation]
Furrow full irrigation	2.95	64%	0.48
Drip irrigation	3.25	90%	0.68
Furrow 10% deficit	2.64	71%	0.48
Furrow 20% deficit	2.35	80%	0.48

Tischbein (2018)

Irrigation experiments with UAF at WMRC

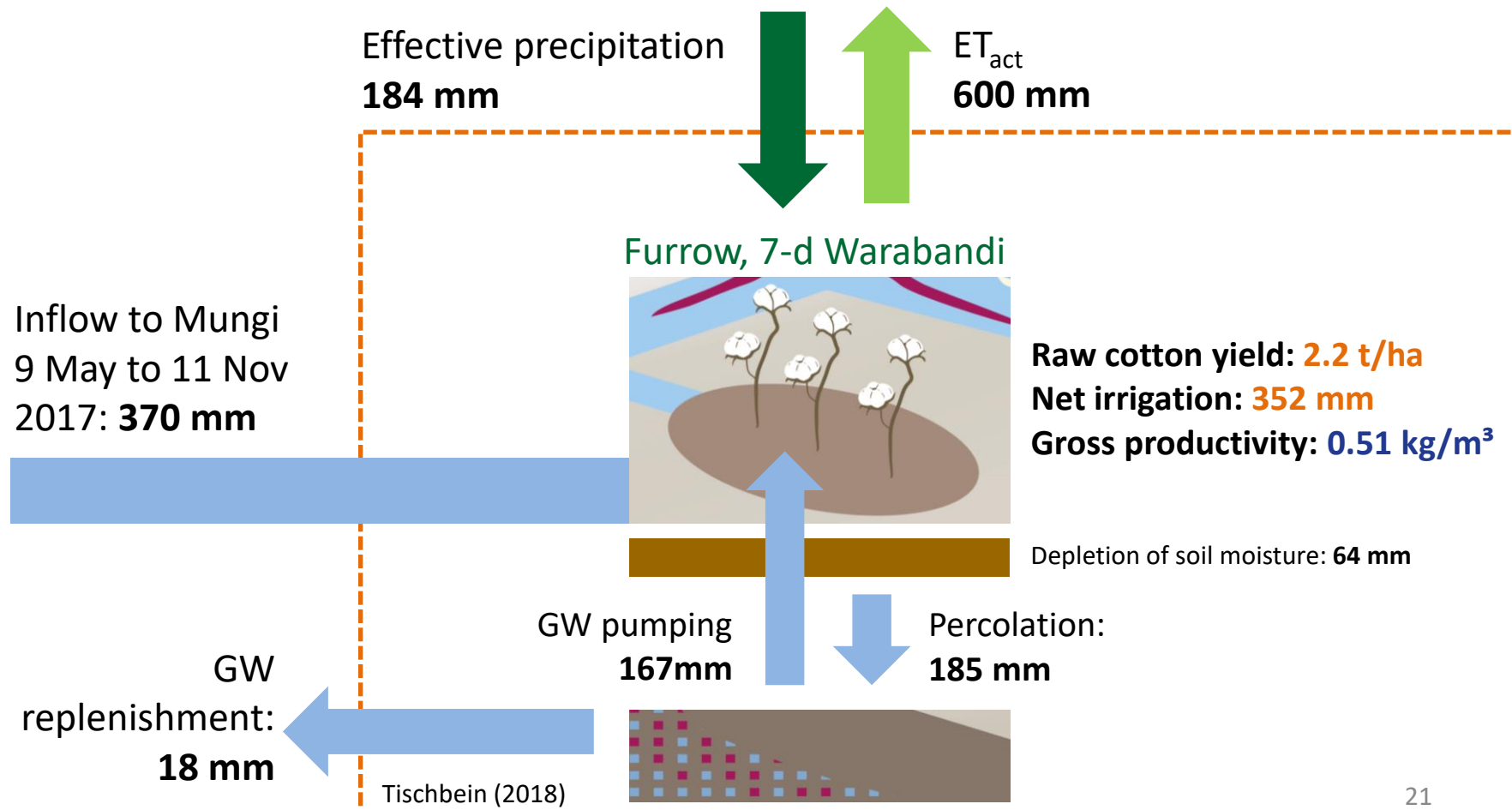


Area supplied by the Mungi Distributary Canal



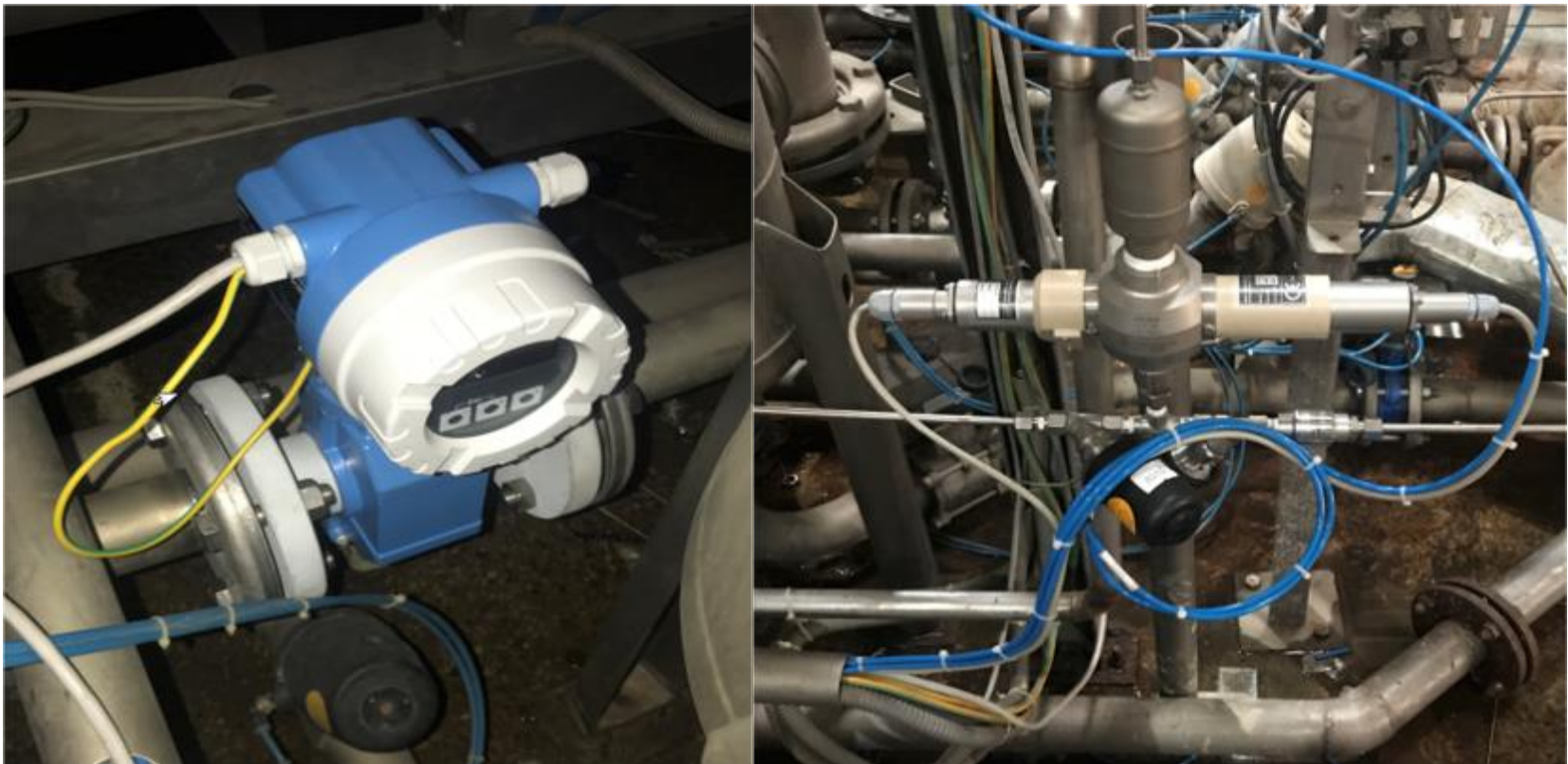
(M2) FLEXIBLE IRRIGATION SCHEDULING IN MUNGI

Options evaluation by FAO-AquaCrop Model



(D2/D3) WATER-EFFICIENCY IN EXHAUST DYEING

From 69 to 52-62 L/kg for black shade dyeing by THIES online process control and down to 38 L/kg by CHT advanced dyestuff 4SUCCESS



(D4) ANAEROBIC TREATMENT OF DESIZING WASTEWATER

63% COD reduction plus biogas production 0.33 m³/kg COD

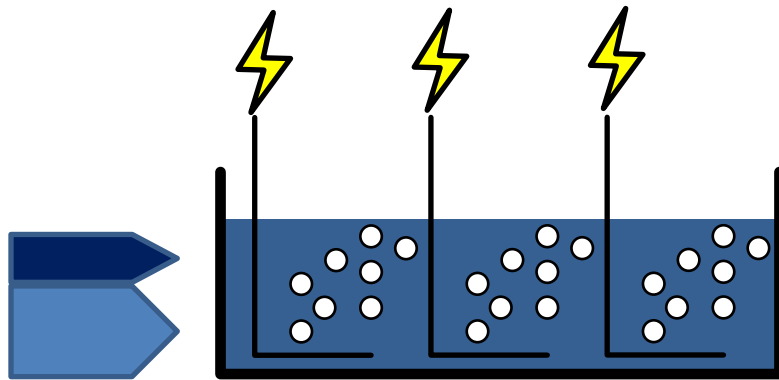


Foto: © FiW

(D4) ANAEROBIC TREATMENT OF DESIZING WASTEWATER

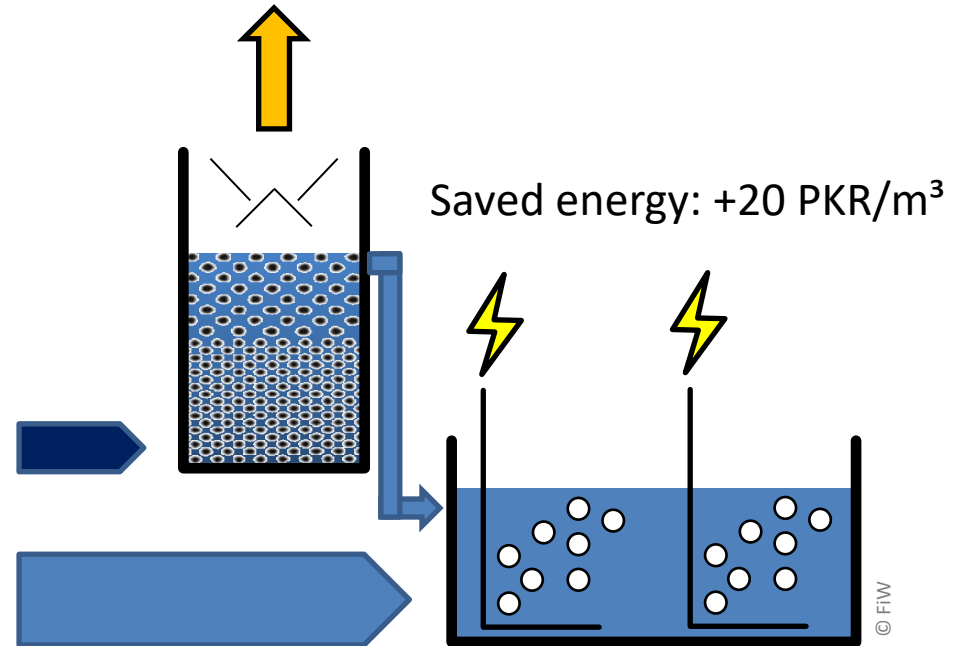
63% COD reduction plus biogas production 0.33 m³/kg COD

Full Aerobic Effluent Treatment Plant for Mixed Textile Wastewater



Aerobic Effluent Treatment Plant after Anaerobic Pretreatment of Desizing Wastewater

Biogas production: +60 PKR/m³ wastewater



Saved energy: +20 PKR/m³

Operation and Maintenance: -30 PKR/m³



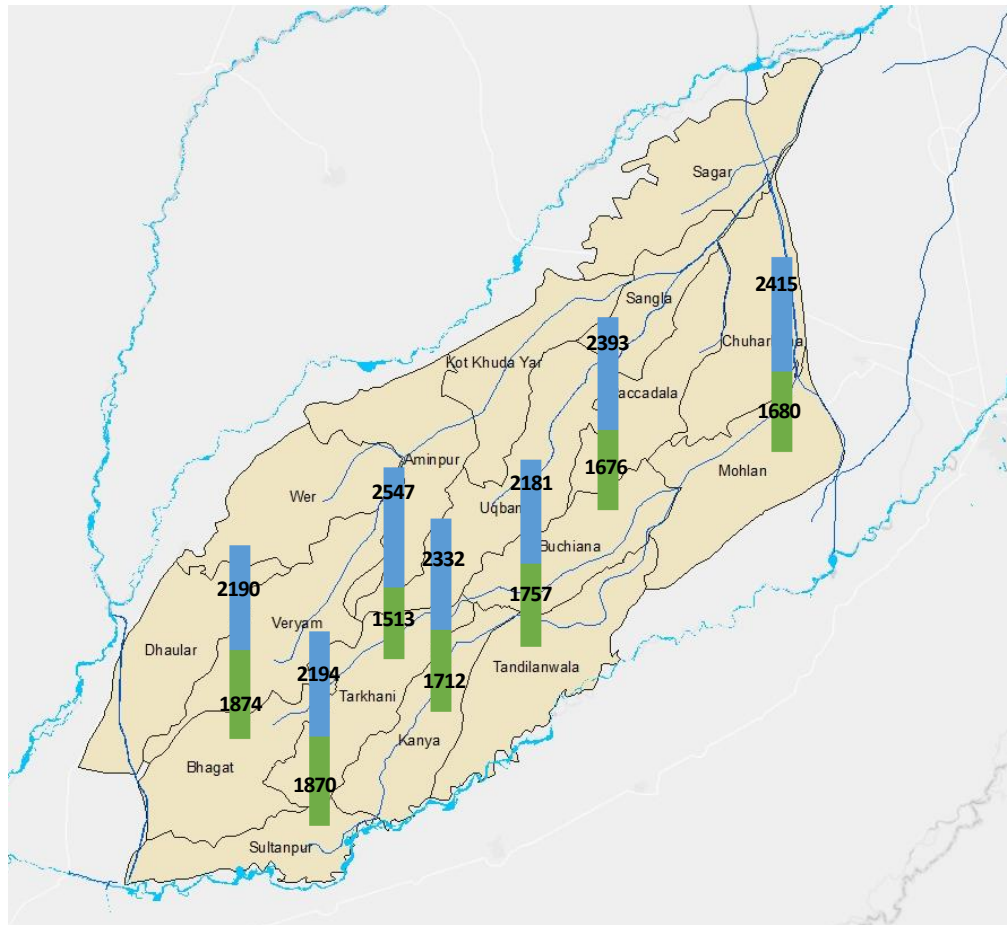
POLICY SCENARIOS FOR REDUCING THE WATER FOOTPRINT TOWARDS ACHIEVING UN-SDGs

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GREEN AND BLUE WATER CONSUMPTION



Water consumption in cotton farming (production weighted average):

2318 L blue/kg raw cotton

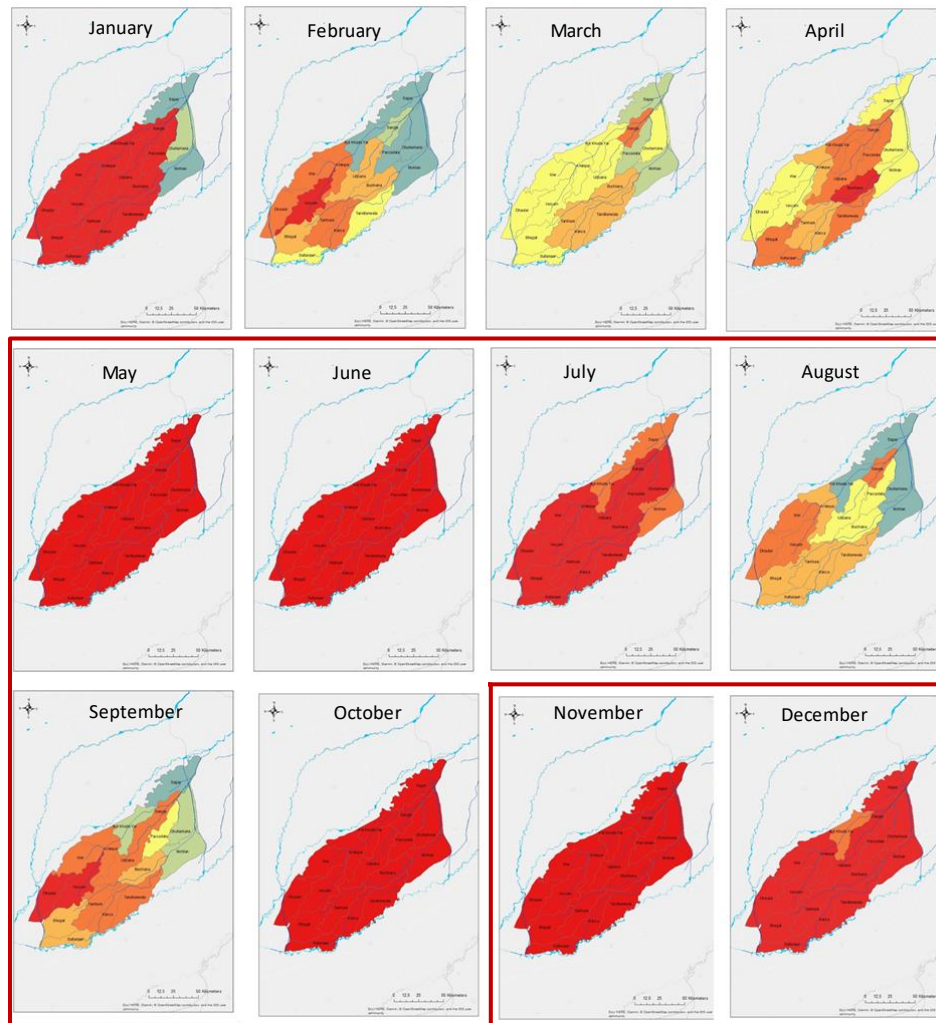
1723 L green/kg raw cotton

higher than previous literature data for Punjab (Mekonnen & Hoekstra, 2011)

1898 L blue water/kg

1122 L green water/kg

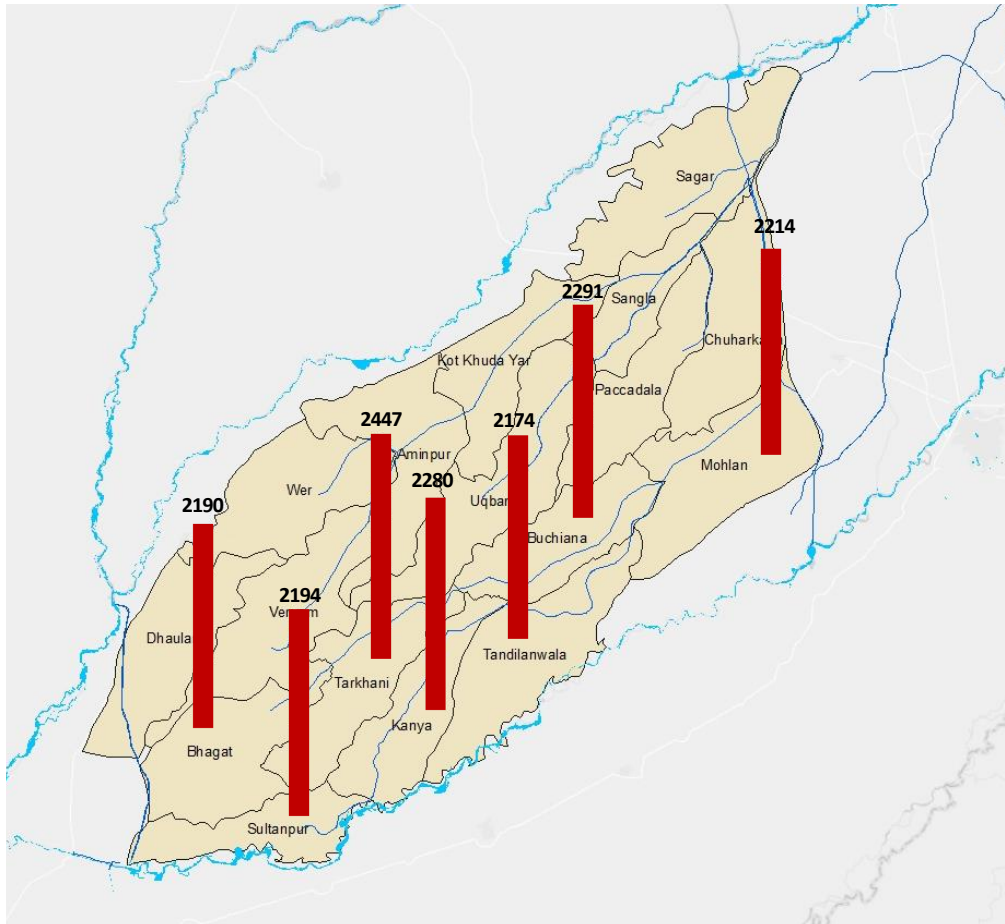
WATER SCARCITY ASSESSMENT



Cotton
growing
season

Finogenova et al. (2018)

WATER SCARCITY FOOTPRINT (WSF)



Water Scarcity Footprint (WSF)
(production weighted average):

2269 L deprived/kg raw cotton

above results obtained using
water scarcity factors on a
country and/or watershed level
(Berger et al., 2014, 2018)

1594 L deprived/kg raw cotton



GREY WATER FOOTPRINT

Cotton Farming

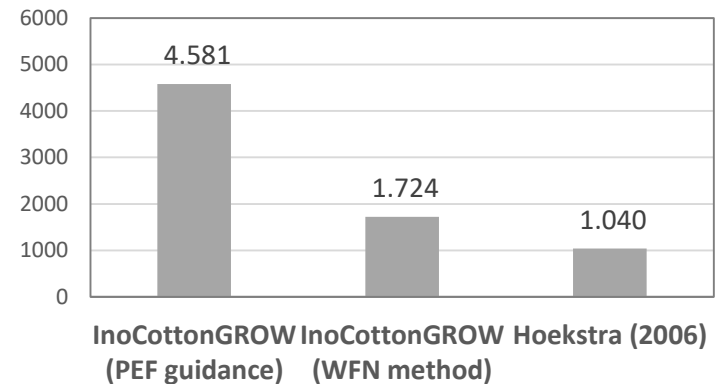
- Calculation based on **NO₃⁻ leaching** from fertilizers (depend on threshold, leaching rate, and calculation method applied)
- **Pesticide toxicity:** impact assessment on human health and ecosystems under way

Textile Wastewater

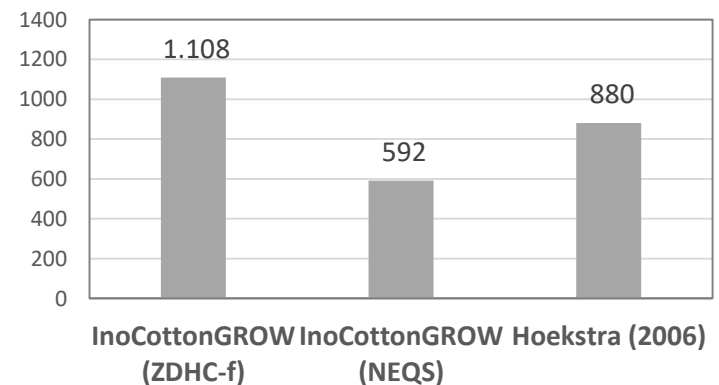
- Calculation based on most penalizing water quality parameters (**BOD or COD**)
- **Heavy metals toxicity:** impact assessment under way

Product Environmental Footprint (PEF)
 Water Footprint Network (WFN)
 Zero Discharge of Hazardous Chemicals, foundational (ZDHC-f)
 National Environmental Quality Standards of Pakistan (NEQS)

Grey WF [L/kg raw cotton]



Grey WF [L/kg fabric]





POLICY SCENARIO: „S2 MANY PENNIES MAKE A DOLLAR“

	Options for intervention	WF	UN-SDGs Indicators
Cotton	• Promotion of flexible irrigation scheduling within Warabandi system	↓	6.4.2 (+) 2.1.1 (+)
	• Promotion of advanced irrigation techniques (e.g., drip)	→	2.3.1 (+)
Textile	• Promotion of water-efficient machinery in textile processing	→	7.b.1 (+)
	• Promotion of advanced dyestuff and process chemicals	→	6.4.1 (+) 12.4.1 (+)
Wastewater	• Installation and operation of effluent WWTPs in all large- and medium-size textile finishing plants	↓	6.1.1 (+) 6.3.1 (+) 3.9.3 (+) 7.3.1 (-)



PRELIMINARY CONCLUSION & NEXT STEPS

1. WF as a Steering Indicator

- Installation of **functioning wastewater treatment** has a main impact on reducing grey water footprint
- For **achieving UN-SDGs**, other measures are also important

2. Workshops, Trainings, and Roadmap IWRM

- **Punjab irrigation reform**: Institutional gaps in water allocation prevail. Monitoring and sanctioning hardly exist
- **Environmental authorities** are currently not in a position to assure compliance with existing wastewater standards

3. Awareness Raising: Brands, Retailers, and Consumers

- **Internet-based WF tool**
- Integration of the WF concept into **textile labels?**
- **12-min Documentary Video** available on YouTube

The background of the entire image is a close-up, soft-focus photograph of white, textured fabric, likely cotton, with various folds and creases. The lighting is bright and even, highlighting the fine details of the textile.

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لئے آپ کا شکریہ۔

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