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Cotton & Water: Understanding Metrics & Use in Industry Tools

PART TWO

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Cotton and Water

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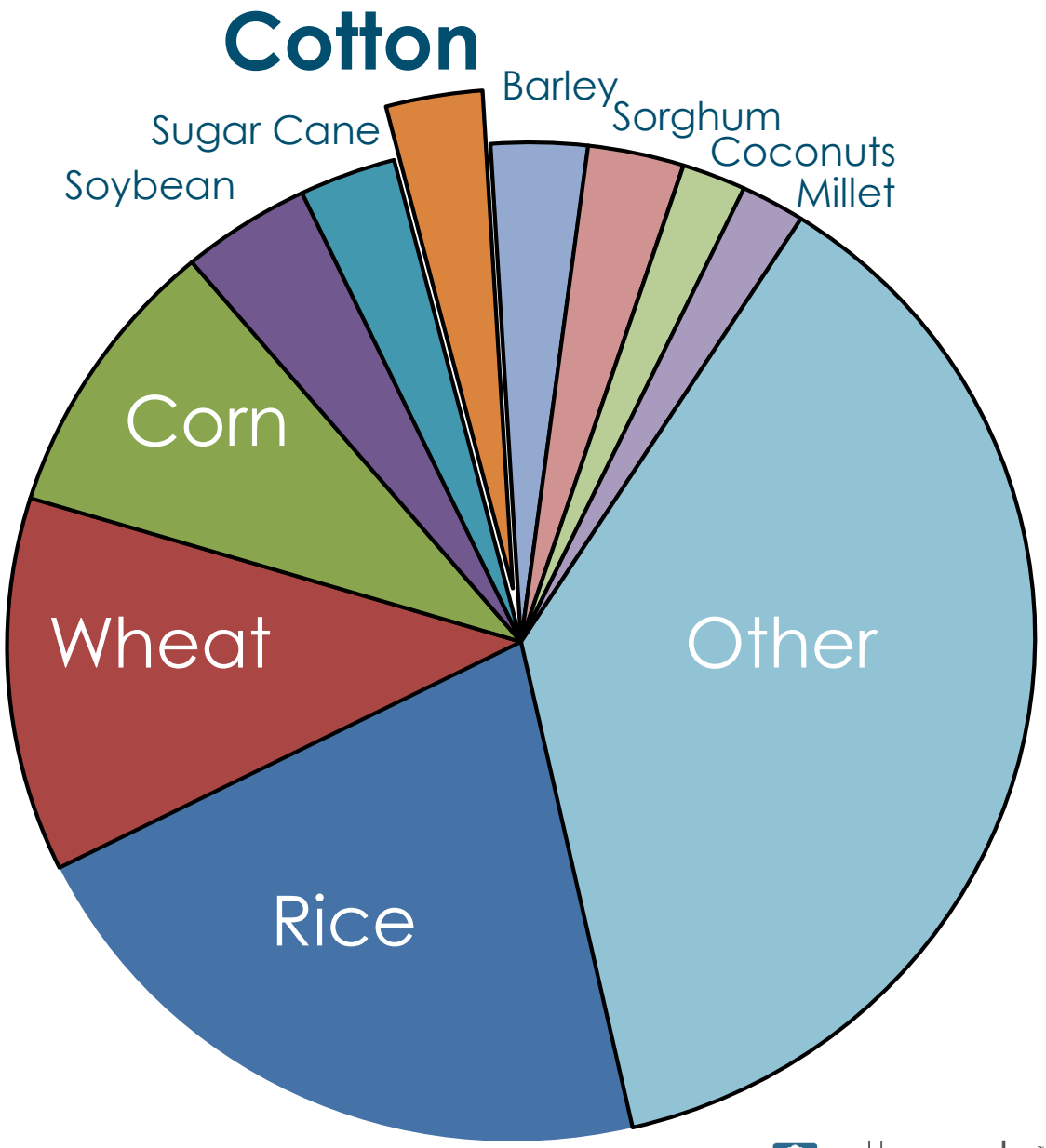
Cotton's Global Water Use

Cotton production uses

3%

of the world's **agricultural water**



Source: Hoekstra, A. Y. & Chapagain, A. K. (2007). Water footprints of nations: water use by people as a function of their consumption pattern. *Water Resource Management*, (21)1, 35–48.

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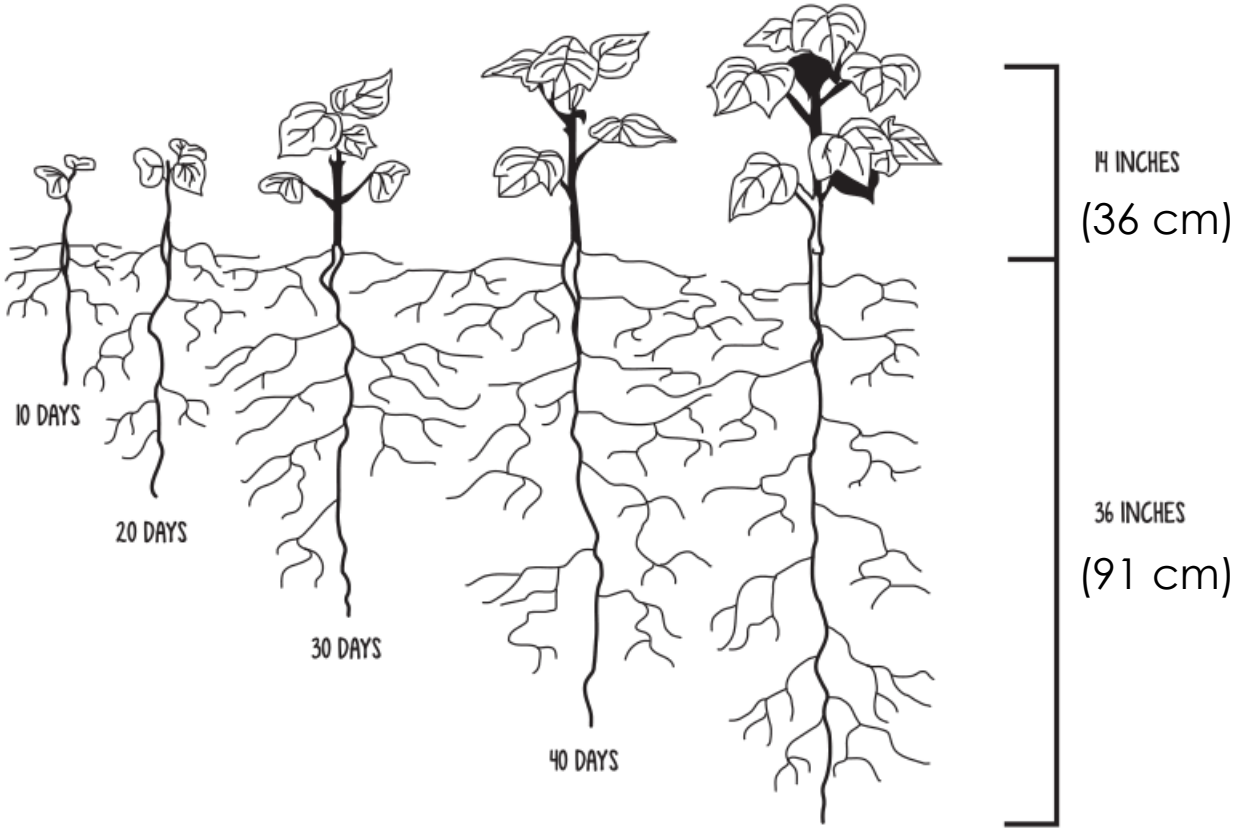
Drought Tolerance

Tap Root Development



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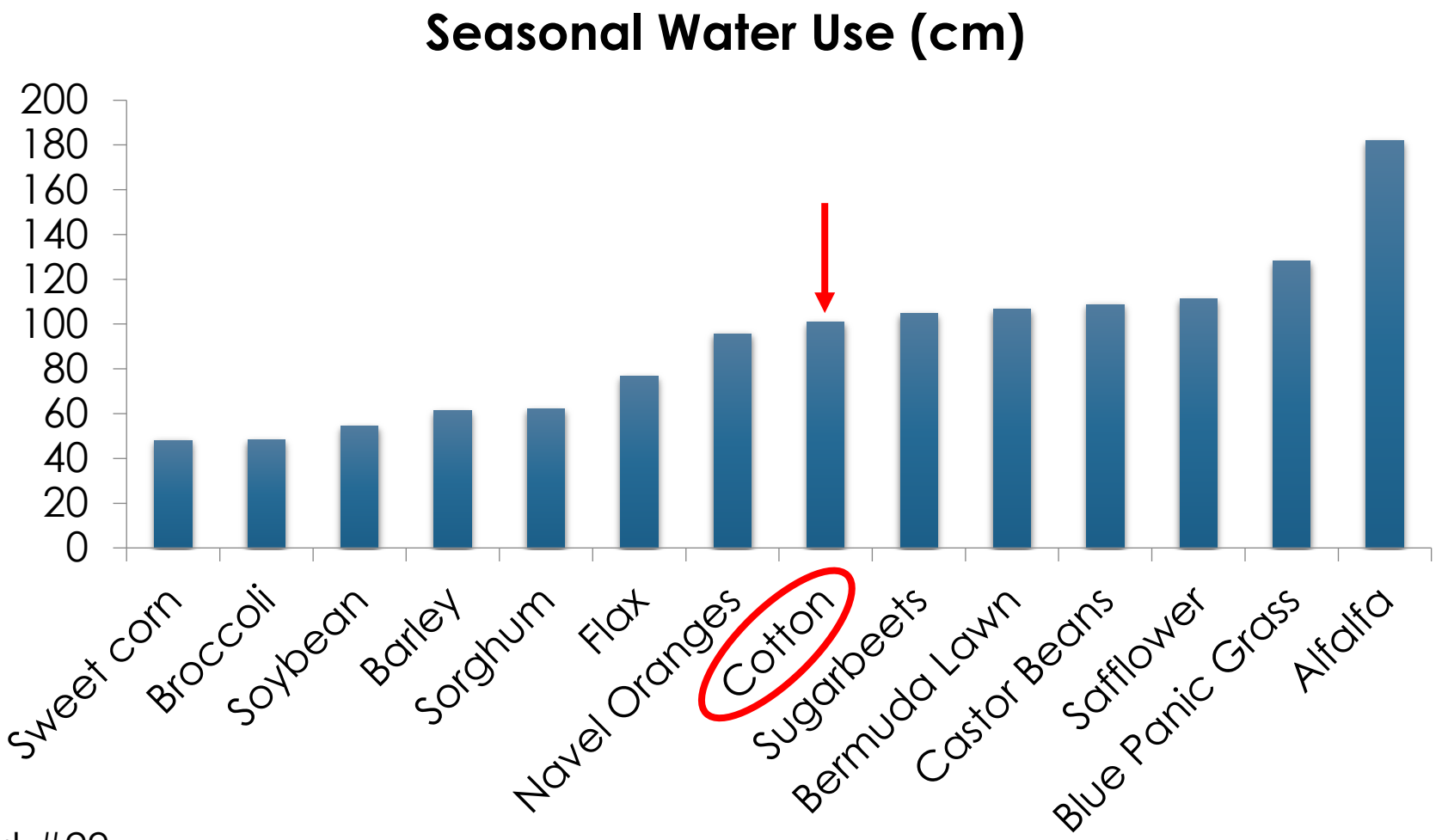
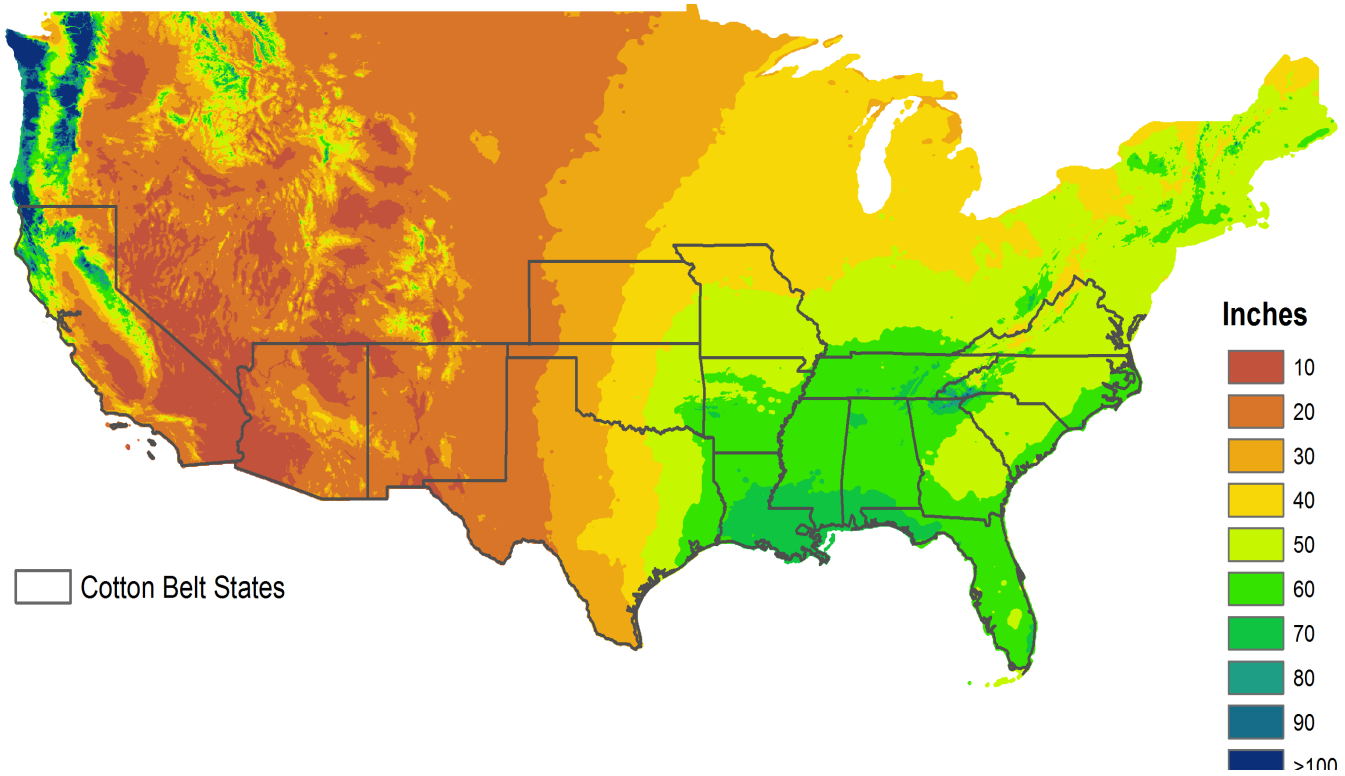
Seasonal Water Use - Arizona



USDA, ARS CR Report #29

U.S. Cotton Crop Largely Rain-Fed

- **60%** of U.S. cotton land requires no irrigation
- Only **4%** of land is fully irrigated



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Cotton's Agricultural Water Summary

- Relative to other crops, cotton is not an excessive water user.
- It is heat and drought tolerant, so it can be grown in water limited regions.
- Modern technologies have greatly increased cotton productivity and decreased cotton's irrigation water use.
- Based on current research progress, the trend towards increased water productivity will continue.

Water Metrics

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In the last century, our use of water worldwide has grown at more than twice the rate of human population growth.

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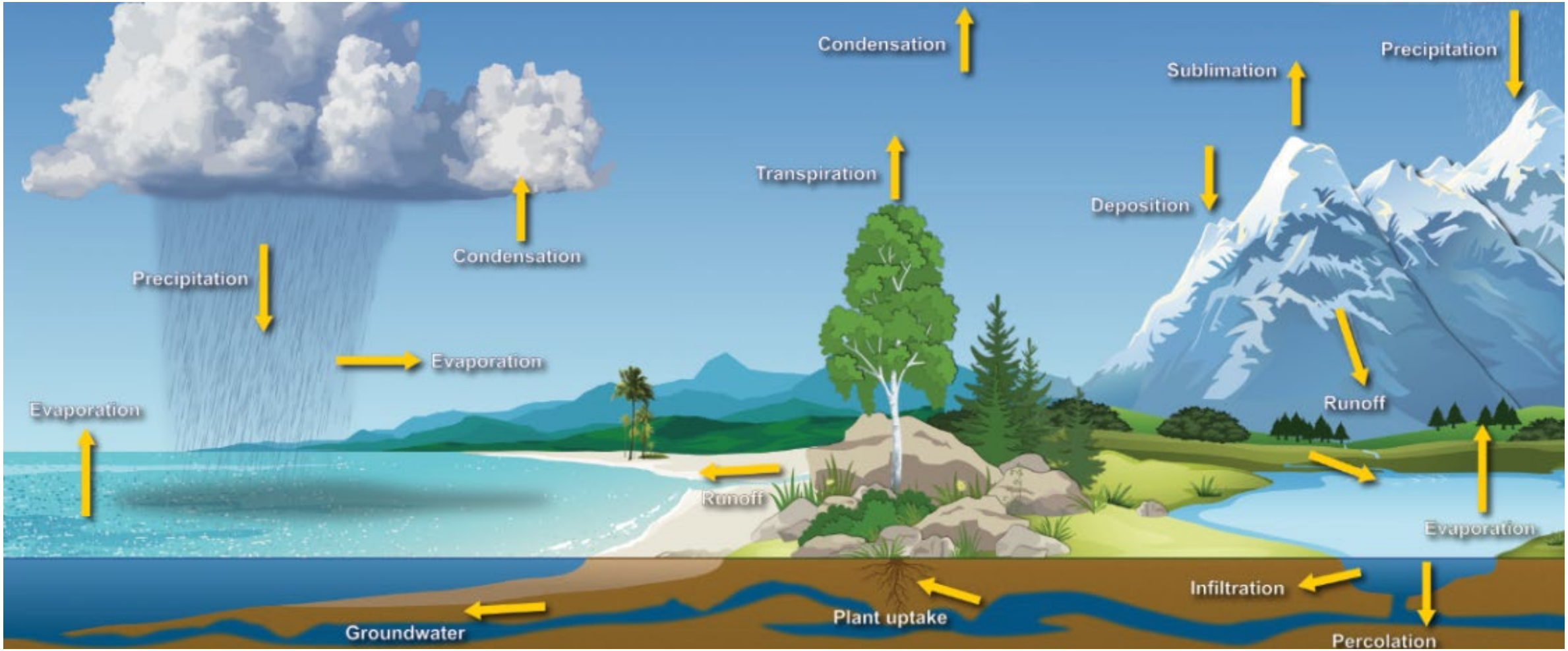
How do we interact with water?

Water Cycle



Source: https://www.noaa.gov/education/resource-collections/freshwater/water-cycle

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Interactions with Water

Water Use/Water Withdraw

Water that has been withdrawn or required for a process/product regardless of whether it is returned or removed from the watershed

Water Consumption

Withdrawn and removed from a water basin through evaporation, imbedded in a product or through other means

Water "Consumption" vs. "Use"

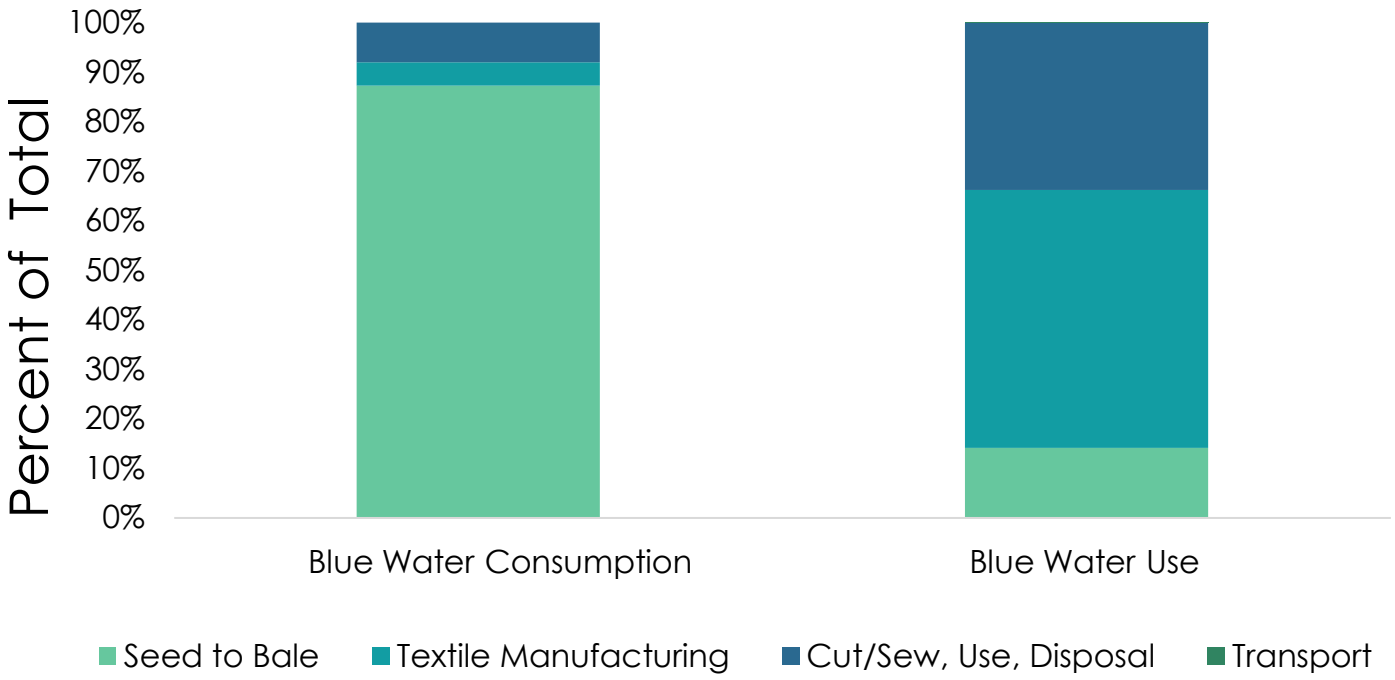
Power Plant Example

Consumption = water that evaporates and is not returned to the river.

Use = withdraw = All water that goes into the power plant.

Water Consumption and Use Hotspots Cradle to Grave

- Collared shirt
  - ~87% water consumption in seed to bale
  - ~14% water use in seed to bale



Source: The Life Cycle Inventory & Life Cycle Assessment of Cotton Fiber & Fabric. (2016). Cotton Incorporated. https://cottontoday.cottoninc.com/wp-content/uploads/2019/11/2016-LCA-Full-Report-Update.pdf

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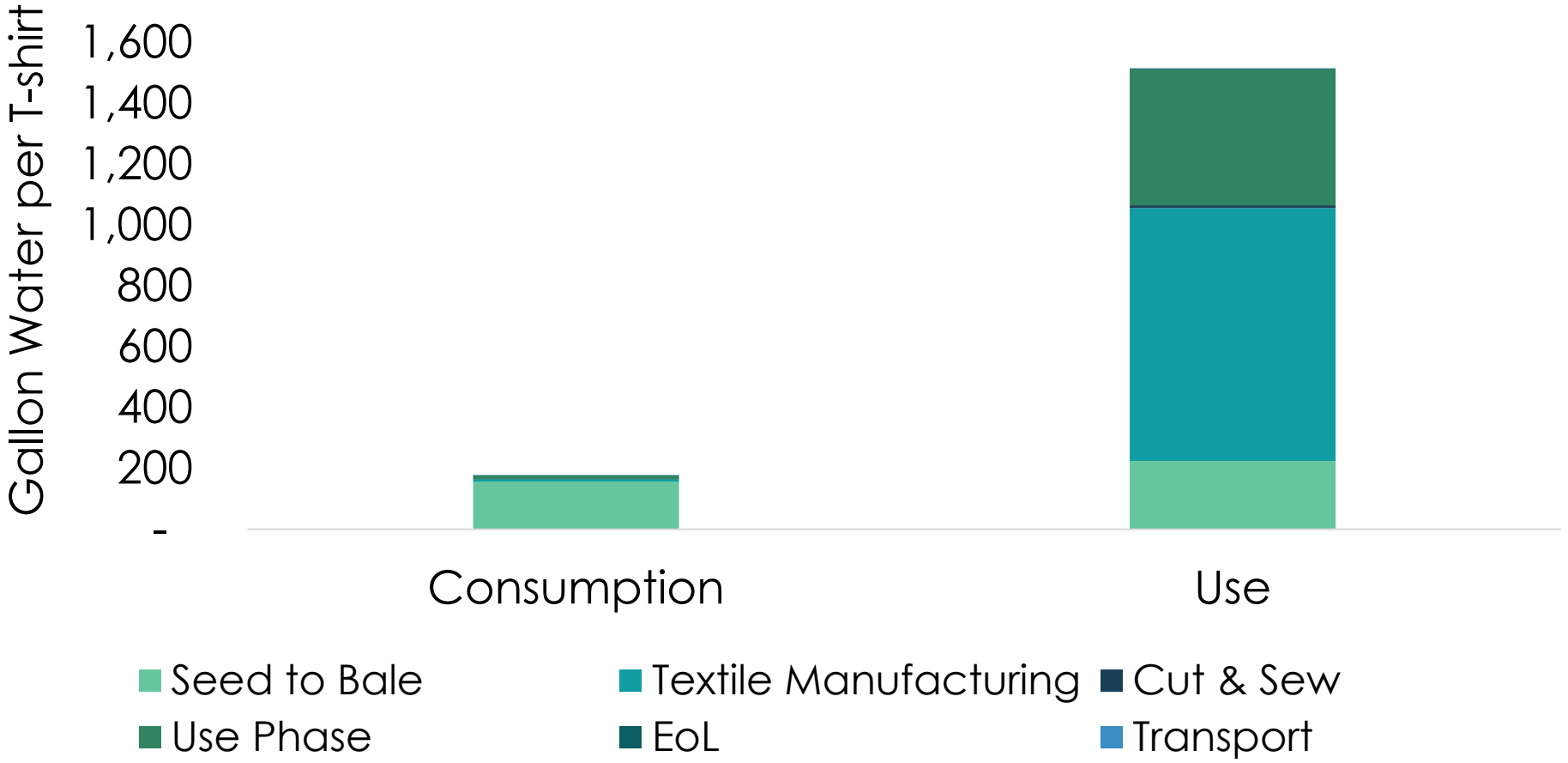
Water Consumption vs. Use



Source: The Life Cycle Inventory & Life Cycle Assessment of Cotton Fiber & Fabric. (2016). Cotton Incorporated. https://cottontoday.cottoninc.com/wp-content/uploads/2019/11/2016-LCA-Full-Report-Update.pdf

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How do we measure the impacts of our interactions?

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Methods for Measuring Impacts

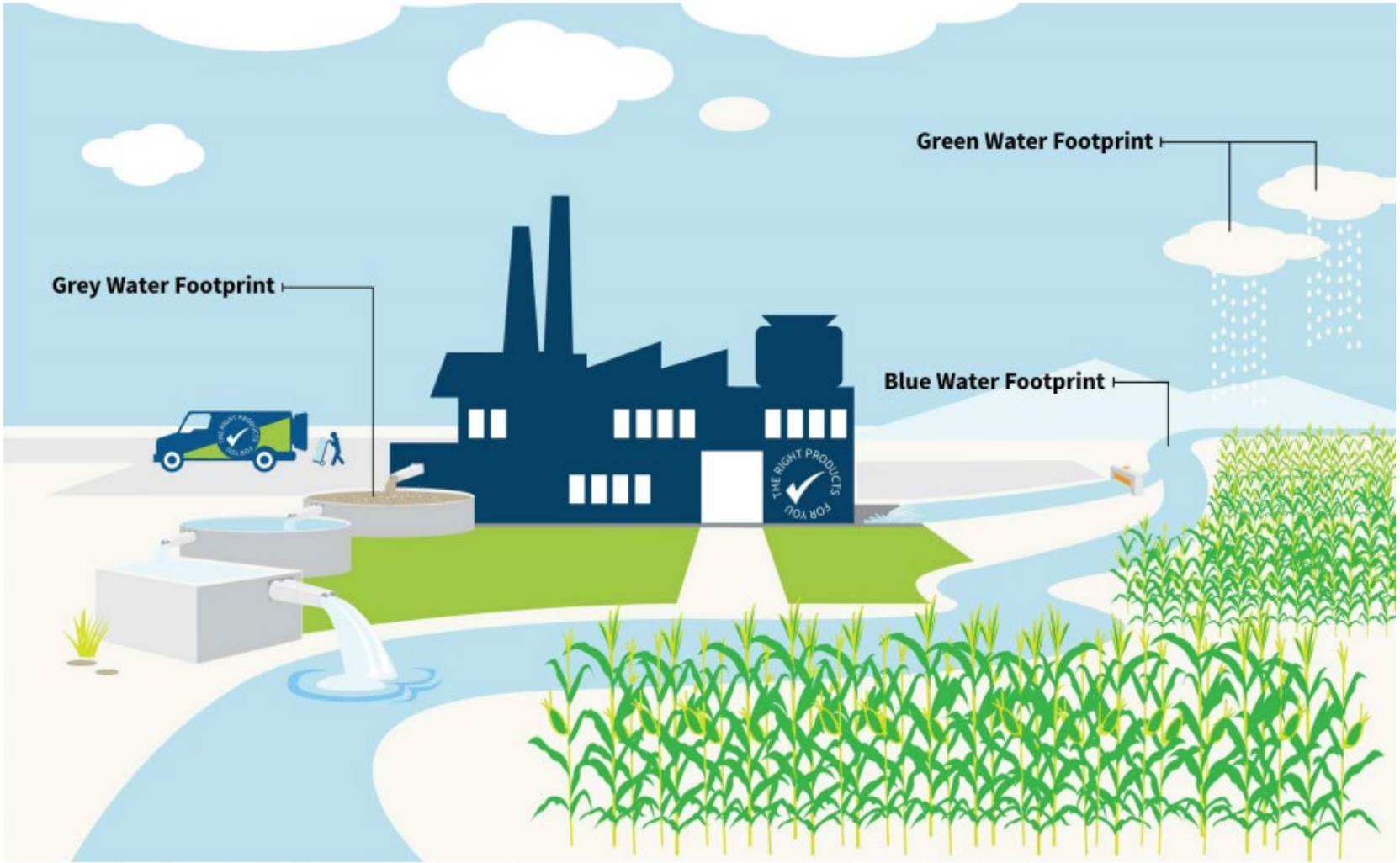
1. Water footprint (WFP)

   waterfootprint.org/en

2. Available water remaining (AWARE)

   wulca-waterlca.org/aware.html

Water Footprints: Blue, Green, and Grey



Water Footprint

The water footprint of a product is an empirical indicator of how much water is consumed, when and where, measured over the whole supply chain of the product.

Source: https://waterfootprint.org/media/downloads/Report-48-WaterFootprint-AnimalProducts-Vol1.pdf

Water Footprint Network

Green water footprint

- volume of rainwater evaporated or incorporated into product

Blue water footprint

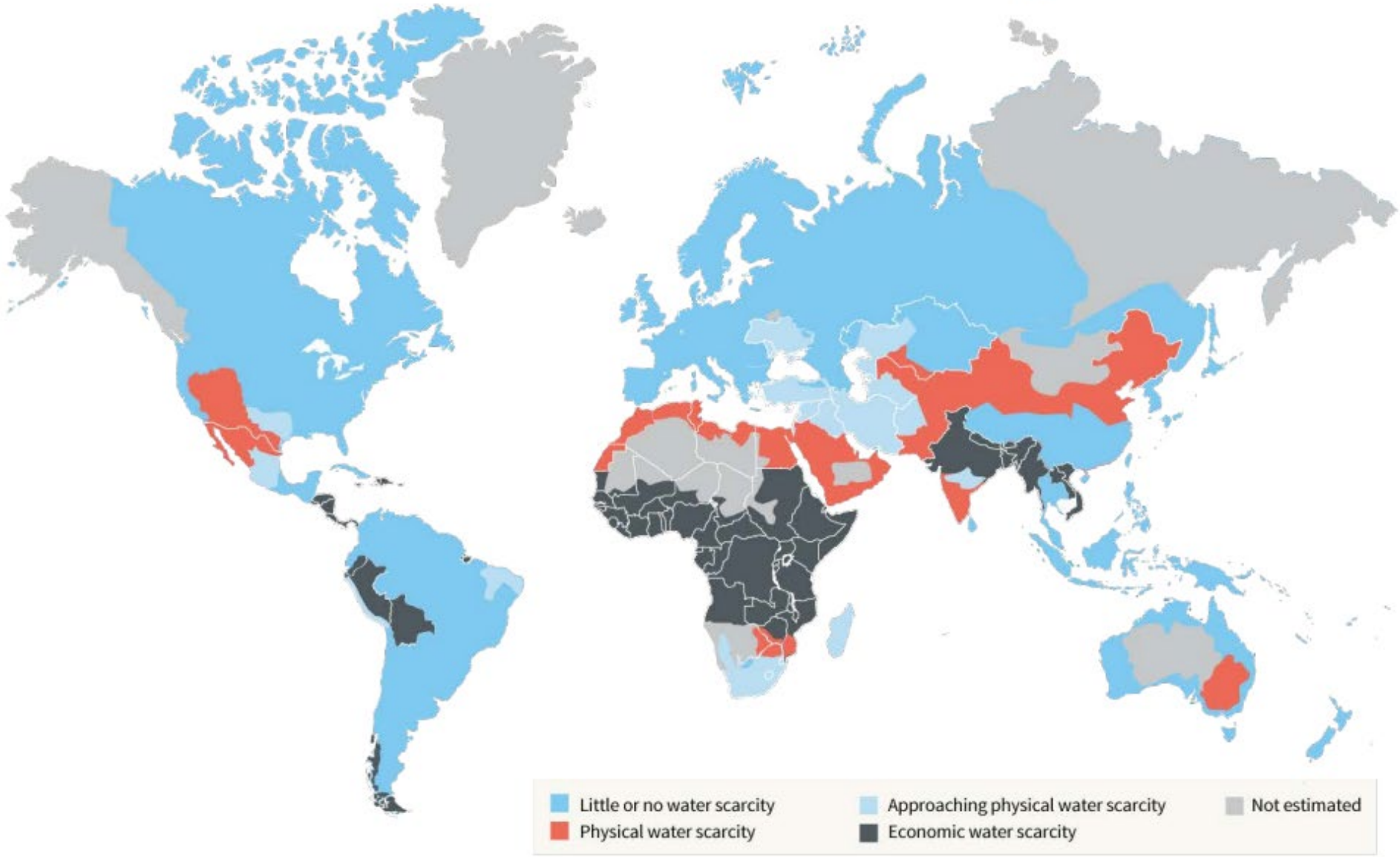
- volume of surface or groundwater evaporated or incorporated into product

Grey water footprint

- volume of water needed to assimilate pollution

Source: Water Footprint Network

Global Water Scarcity



Available WAter REmaining (AWARE)

Asking the Right Question…

What is the potential of depriving another user of water (human or ecosystems) when consuming water in this area?

Developed by a multi-stakeholder initiative

Water Use in Life Cycle Assessment (WULCA)

wulca-waterlca.org/aware.html

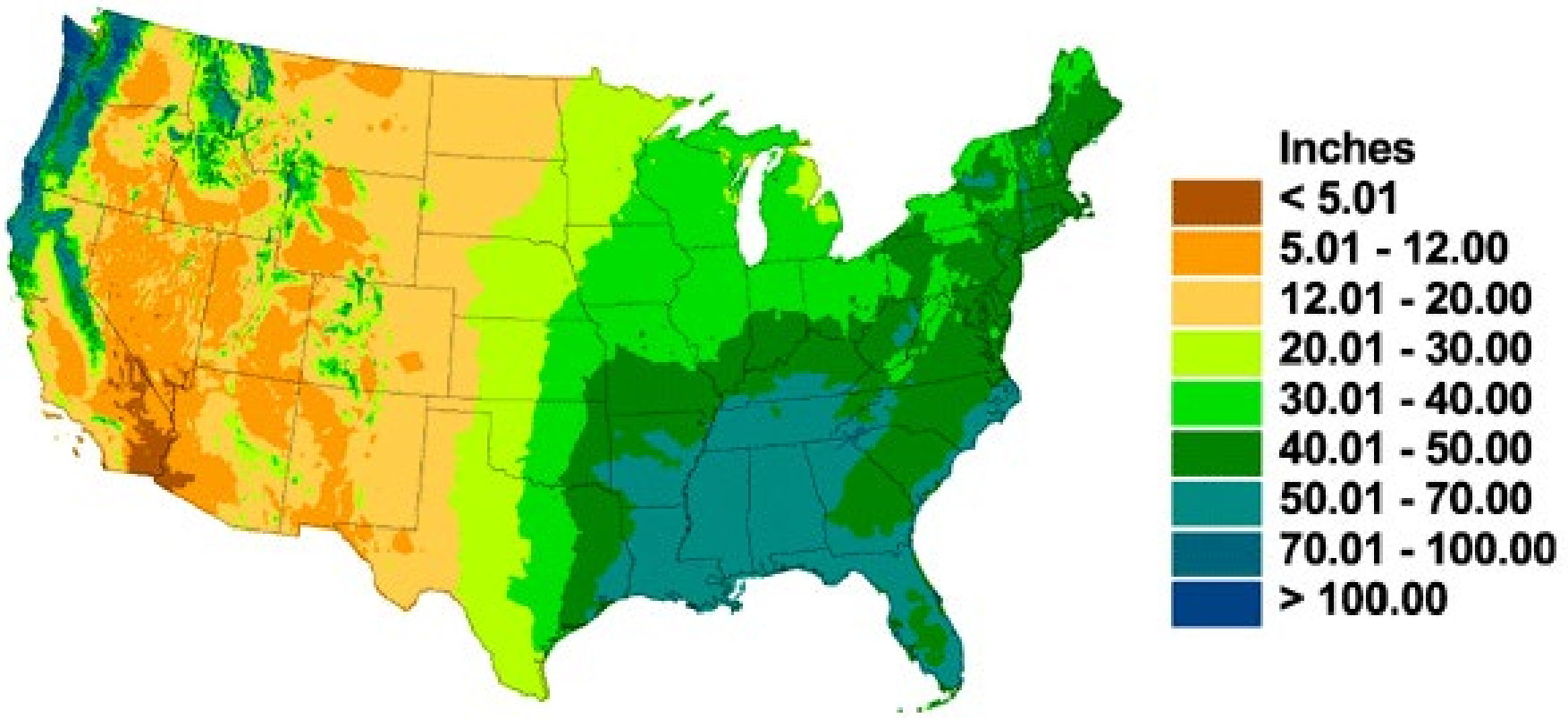
ISO 14046 Water Footprint Guidance

- Should be life-cycle based
- Could be "stand-alone" or part of a full life cycle assessment
- Results should include impact assessment (volumes not sufficient) and address regional issues
- Both quantity and quality should be considered
- Comprehensive impact assessment related to water
- Can result in one or several indicators

Source: Anne-Marie Boulay, CIRAIG; Samuel Vionnet, Quantis, San Francisco, 10-8-2014

Why Location Matters

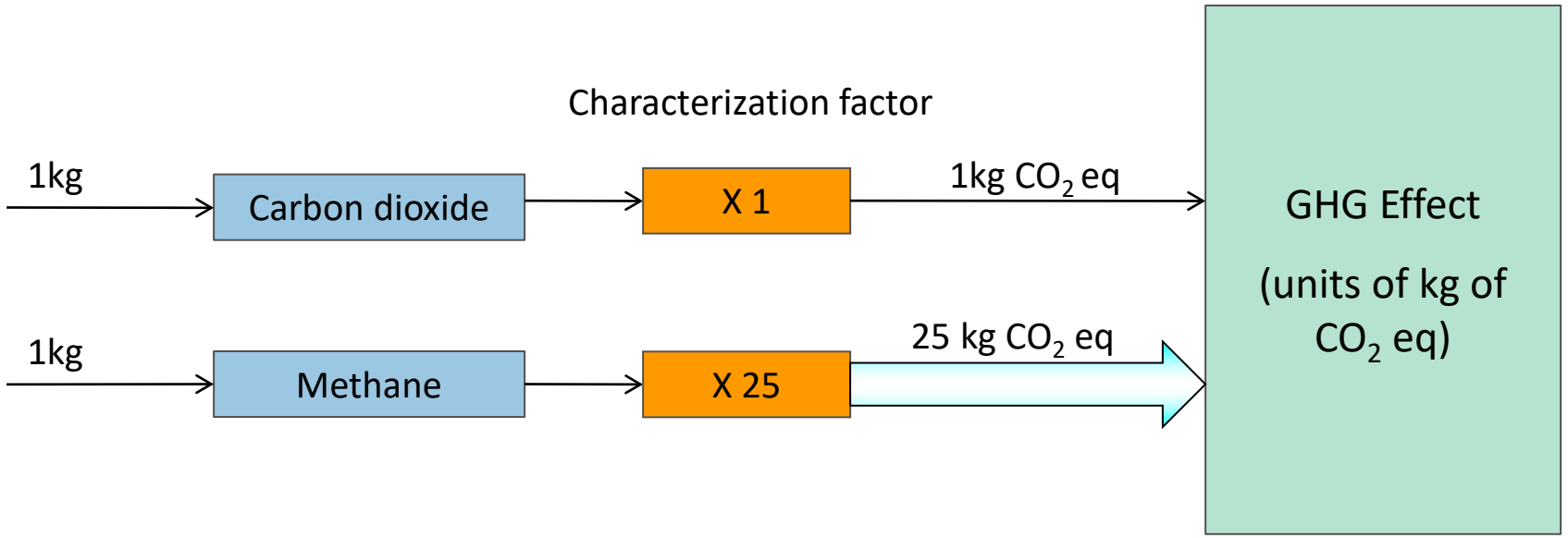
Annual Mean Total Precipitation



Source: https://celebrating200years.noaa.gov/visions/climate/image4.html

Impact Assessment: Characterization

Characterization factor: factor derived from a characterization model which is applied to convert an assigned life cycle inventory result to category midpoint indicators and to category endpoints [ISO 14044:2006E]



Source: http://www.epa.gov/RDEE/energy-resources/calculator.html#results

Relating Water Consumption to Impacts

m^3 of water equivalents

Quantity of water removed from watershed

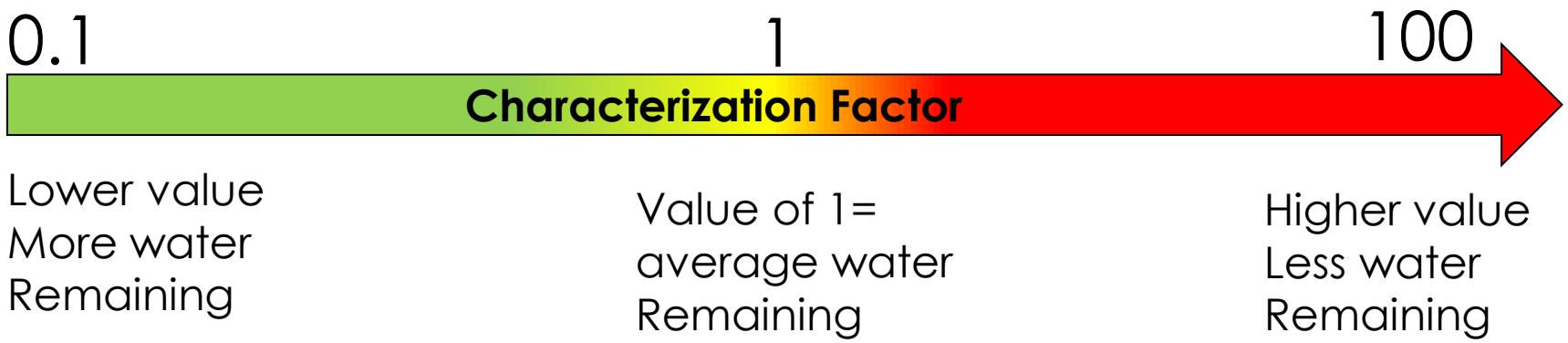
Characterization factor is related to water stress.

Sources:
Boulay, A.-M., Bare, J., Benini, L., Berger, M., Lathuillière, M. J., Manzardo, A., Margni, M., Motoshita, M., Núñez, M., Pastor, A. V., Ridoutt, B., Oki, T., Worbe, S., & Pfister, S. (2017). The WULCA consensus characterization model for water scarcity footprints: assessing impacts of water consumption based on available water remaining (AWARE). The International Journal of Life Cycle Assessment, 23(2), 368–378. https://doi.org/10.1007/s11367-017-1333-8

WULCA. (2010). Consensus-based method development to assess water use in LCA. http://www.wulca-waterlca.org/aware.html

AWARE Characterization Factor (CF)

- Unused water remaining =(Availability-Demand)
- Demand includes
  - Human requirements
  - Aquatic ecosystems
- CF maximal value when Demand >availability



Sources:
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WULCA. (2010). Consensus-based method development to assess water use in LCA. http://www.wulca-waterlca.org/aware.html

AWARE Characterization Factor

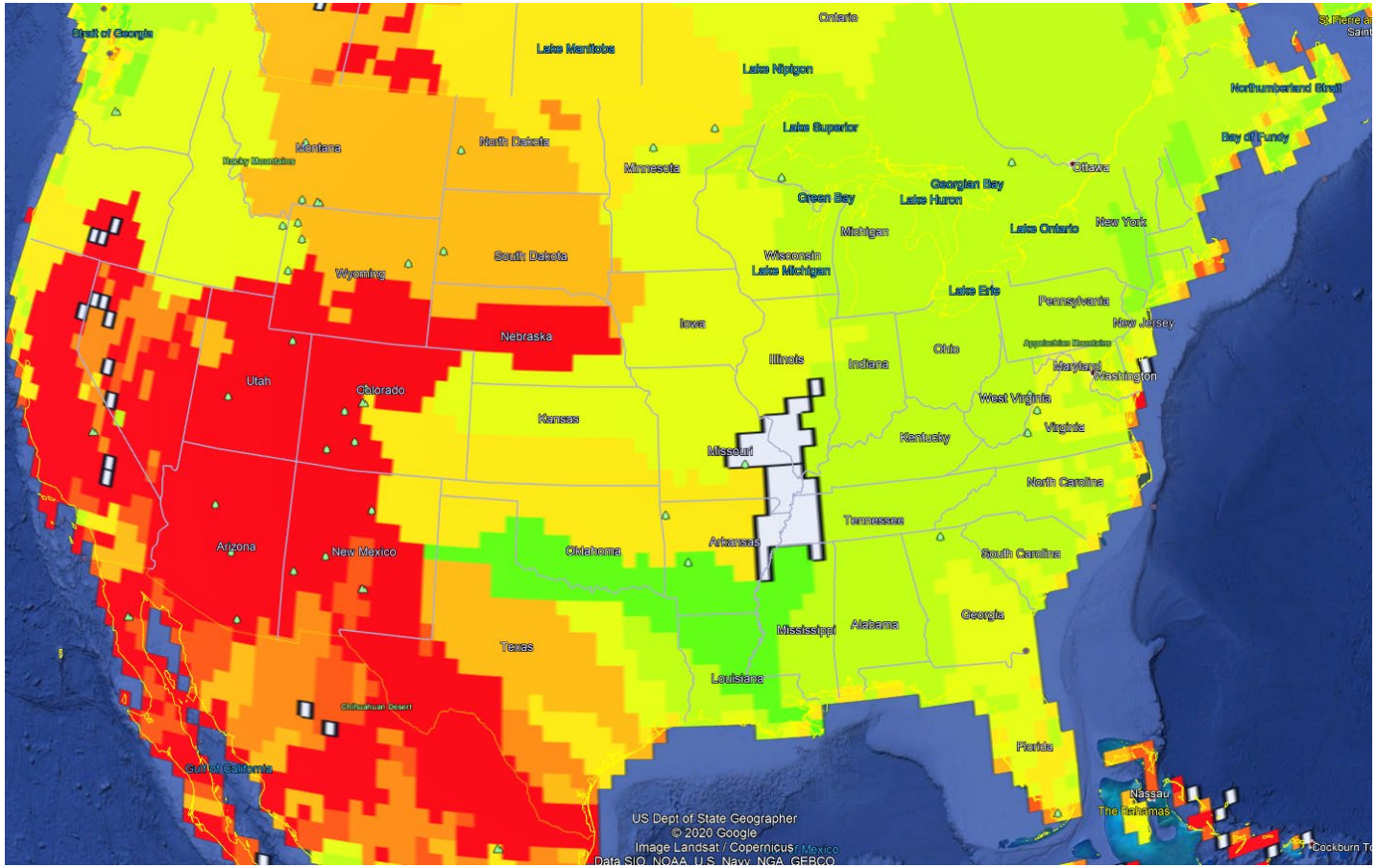
- Characterization factors in water remaining per area per time
  - Value of 1=world average
  - Value <1 water less scarce than world average
  - Value >1 water more scarce than world average

- Upper cutoff of 100
    - Represents 38% of the world consumption
- Lower cutoff of 0.1
    - Less than 1% of world consumption

Sources:
Boulay, A.-M., Bare, J., Benini, L., Berger, M., Lathuillière, M. J., Manzardo, A., Margni, M., Motoshita, M., Núñez, M., Pastor, A. V., Ridoutt, B., Oki, T., Worbe, S., & Pfister, S. (2017). The WULCA consensus characterization model for water scarcity footprints: assessing impacts of water consumption based on available water remaining (AWARE). The International Journal of Life Cycle Assessment, 23(2), 368–378. https://doi.org/10.1007/s11367-017-1333-8

WULCA. (2010). Consensus-based method development to assess water use in LCA. http://www.wulca-waterlca.org/aware.html

AWARE Characterization Factors



Sources:
Boulay, A.-M., Bare, J., Benini, L., Berger, M., Lathuillière, M. J., Manzardo, A., Margni, M., Motoshita, M., Núñez, M., Pastor, A. V., Ridoutt, B., Oki, T., Worbe, S., & Pfister, S. (2017). The WULCA consensus characterization model for water scarcity footprints: assessing impacts of water consumption based on available water remaining (AWARE). The International Journal of Life Cycle Assessment, 23(2), 368–378. https://doi.org/10.1007/s11367-017-1333-8

WULCA. (2010). Consensus-based method development to assess water use in LCA. http://www.wulca-waterlca.org/aware.html

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Method Comparison

	WFP	AWARE
Includes blue water	+	+
Includes green water	+	
Includes gray water	+	
Focuses on water consumption	+	+
Inventory data includes water volume	+	+
Accounts for water availability in a region		+
Accounts for water scarcity/stress in a region		+
High resolution inventory data		+
Inventory data separates geographic regions	+	+
Addresses water quality		+
Measures water impact		+
Takes into account both human and ecological needs		+
Created with LCA framework and ISO standards		+
Includes a characterization factor		+

Sources:
WULCA. (2010). Consensus-based method development to assess water use in LCA. http://www.wulca-waterlca.org/aware.html

Hoekstra, A., Chapagain, A., Aldaya, M., & Mekonnen, M. (2011). The Water Footprint Assessment Manual Setting the Global Standard. https://waterfootprint.org/media/downloads/TheWaterFootprintAssessmentManual_2.pdf

Water and Higg MSI

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Higg Index Impact Categories

- Global warming potential (kg CO2 eq.)

- Eutrophication (kg PO4 eq.)

- Water scarcity (m^3 H2O eq.)

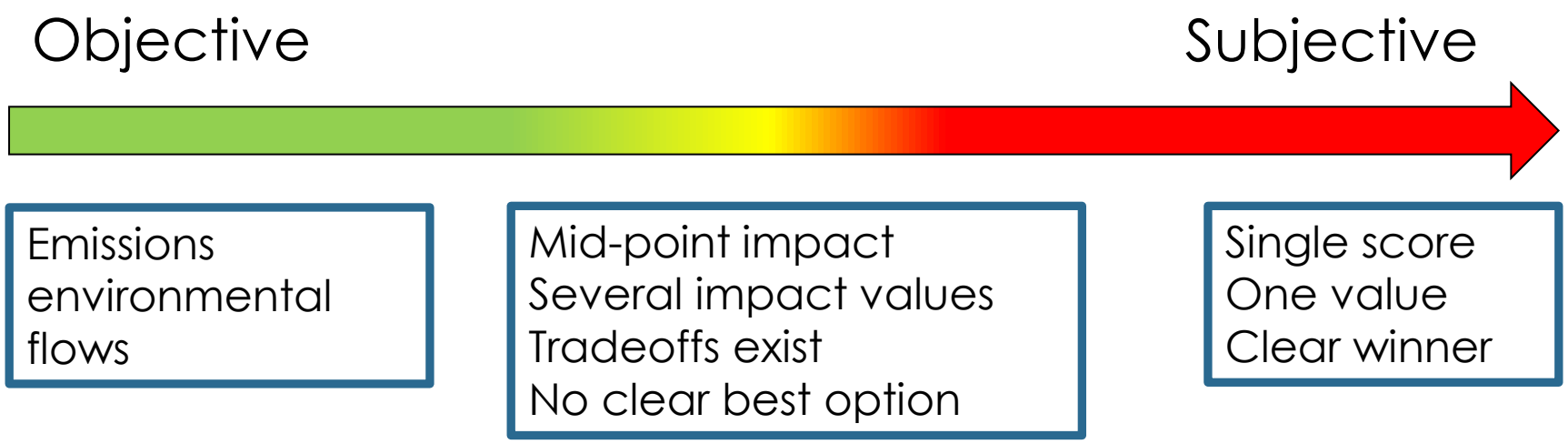
- Abiotic depletion (MJ eq.)

- Chemistry (certifications)

Source: Higg Materials Sustainability Index (MSI) Methodology. (2019). Sustainable Apparel Coalition. https://msi.higg.org/uploads/msi.higg.org/sac_textpage_section_files/27/file/MSI_Methodology_8-6-19.pdf

Higg Single Score Method

- Emissions flows divided by normalization factor then multiplied by a weighting factor
- All impact categories weighted equally

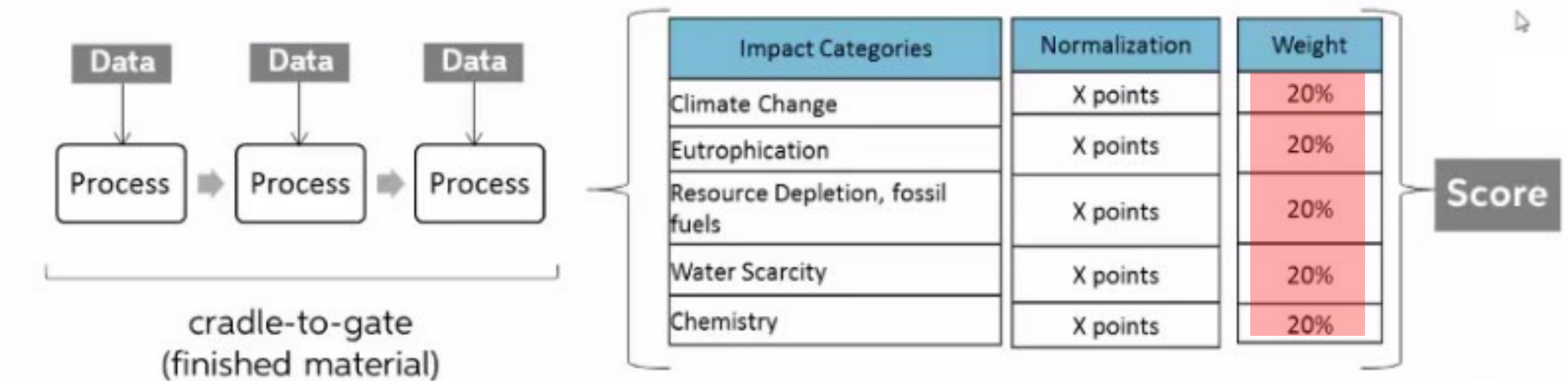


Source: Higg Materials Sustainability Index (MSI) Methodology. (2019). Sustainable Apparel Coalition. https://msi.higg.org/uploads/msi.higg.org/sac_textpage_section_files/27/file/MSI_Methodology_8-6-19.pdf

Higg MSI Methodology

Is water consumption as important as…

- Climate change?
- Fossil fuel use?
- Water quality?



Source: Higg Materials Sustainability Index (MSI) Methodology. (2019). Sustainable Apparel Coalition. https://msi.higg.org/uploads/msi.higg.org/sac_textpage_section_files/27/file/MSI_Methodology_8-6-19.pdf

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Higg Material Sustainability Index

For 1 kg Cotton

	Impact area	MSI Score	Midpoint
	Global Warming	2.2	2.1711 kg CO_2 eq
	Eutrophication	9.1	0.0091 kg PO_4-- eq
	Water Scarcity	47.6	1.4409 m^3
	Abiotic Resource Depletion, Fossil Fuels	1.7	22.6769 MJ eq

Total Points 60.6

Source: Higg Materials Sustainability Index. (May 14, 2020). Sustainable Apparel Coalition - Higg MSI. https://msi.higg.org/page/msi-home

These results were calculated using the Higg Materials Sustainability Index (Higg MSI) developed by the Sustainable Apparel Coalition (SAC). The Higg MSI assesses impacts of materials from cradle-to-gate for a finished material (i.e. to the point at which materials are ready to be assembled into a product). The Higg MSI scores or percent calculations provided herein account for a single production stage within the Higg MSI scope (e.g. fiber or raw material). They do not provide a holistic view of the impacts involved with material production. SAC does not verify results of user customized materials.

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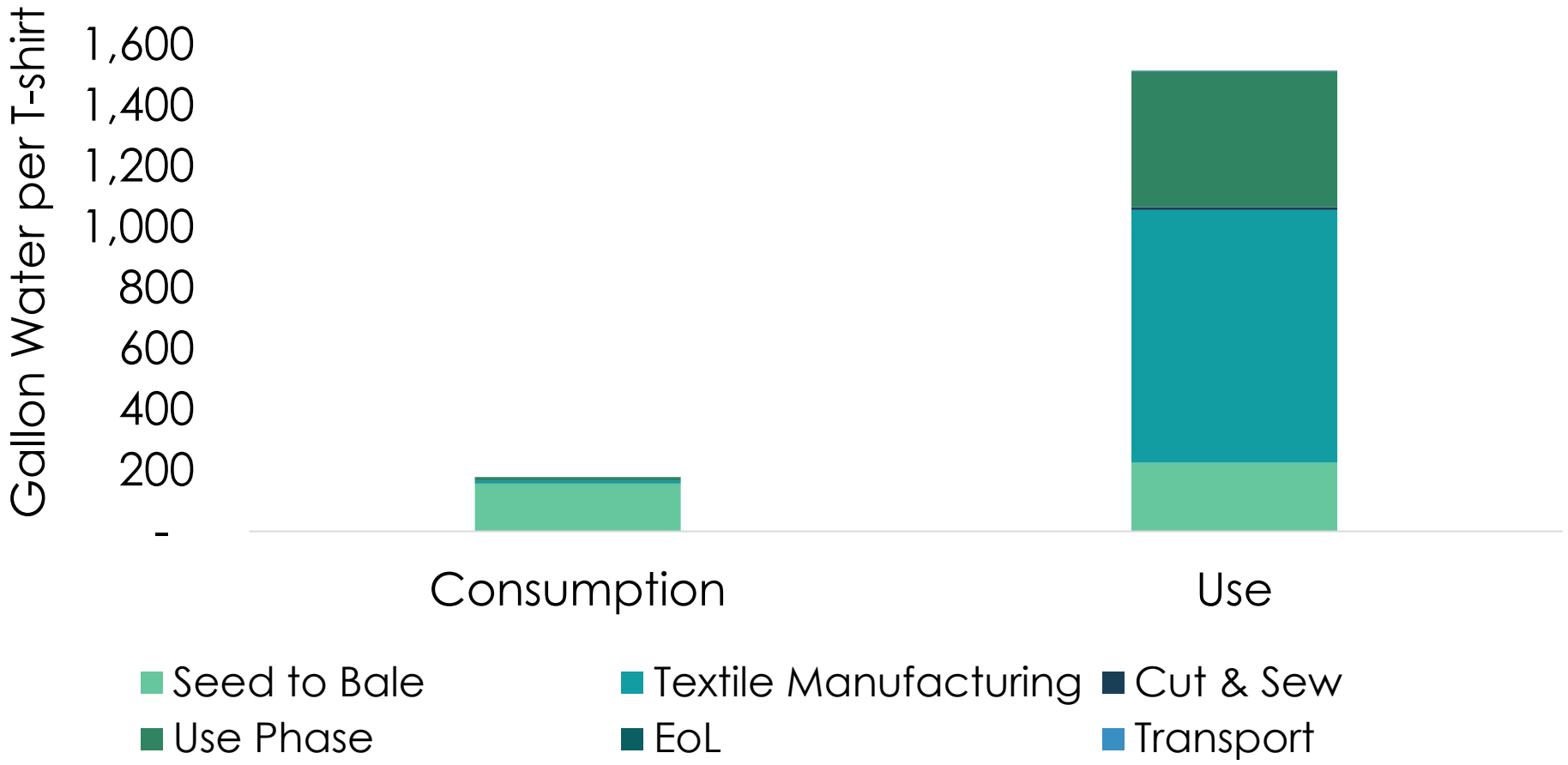
Water Consumption Vs. Use



Source: The Life Cycle Inventory & Life Cycle Assessment of Cotton Fiber & Fabric. (2016). Cotton Incorporated.

Caution in Interpretation of Higg MSI

- MSI Score are reported in "points" which are based on subjective weighting
- MSI points do not have a physical meaning
- Higg MSI assumes all 4 impact categories are equal in importance
- Water footprint and use is not considered in MSI
  - Advantages textile processing and energy intensive fibers

Source: Higg Materials Sustainability Index (MSI) Methodology. (2019). Sustainable Apparel Coalition. https://msi.higg.org/uploads/msi.higg.org/sac_textpage_section_files/27/file/MSI_Methodology_8-6-19.pdf

Other Limitations…

Full webinar on plastic leakage by Quantis at Cottonworks™

Conclusions

- Cotton is a drought tolerant crop and uses only 3% of the agriculture water and 3% of agriculture land
- Water used for cotton cultivation is cycled through the natural water cycle and is not “lost” or destroyed
- Both water consumption and water use are important measures
- Irrigation drives water consumption, but textile processing and consumer use drive water use scores
- Higg MSI scores are based on the AWARE method and report m^3 water equivalents and not actual water use/consumption

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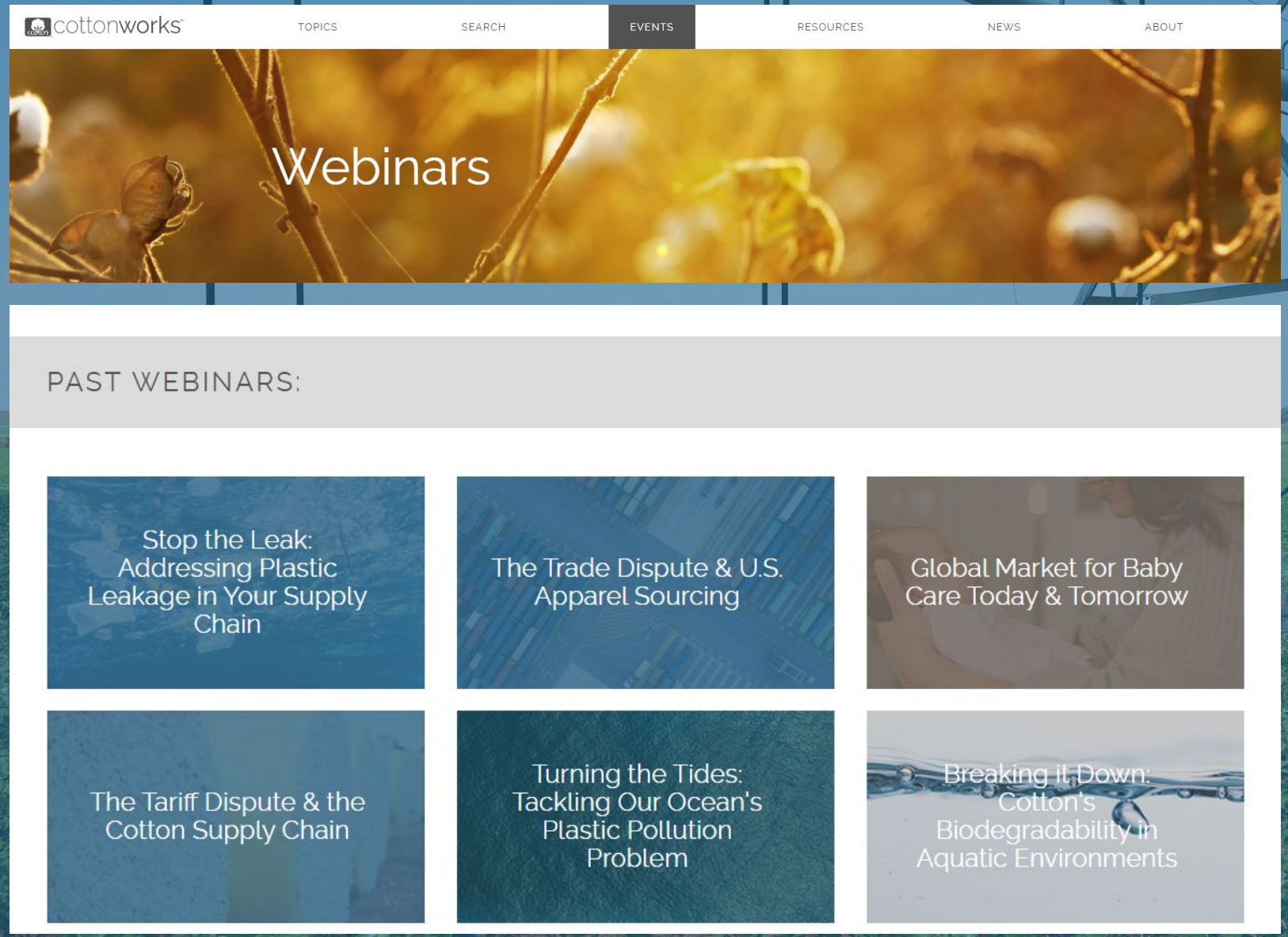

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Cotton Sustainability

Topics > Sustainability > Cotton Sustainability

Recycled Cotton

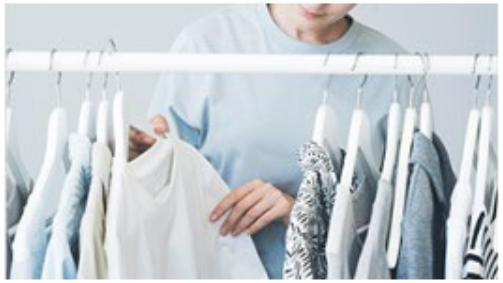
The use of recycled materials is a growing topic of interest and recycled cotton can find new life in many different products.

Biodegradability of Cotton

What happens when your favorite cotton shirt finally reaches the end of its functional life? Explore this natural fiber's afterlife.

Life Cycle Assessment of Cotton

This presentation will identify key impact areas and elaborate on environmental benchmarking for cotton.



Consumer Perceptions

Explore consumer perceptions relating to cotton and cotton sustainability using ongoing research from Cotton Incorporated.

Cotton LEADS℠

The Cotton LEADS℠ program strives to make sure cotton is produced responsibly now and for years to come.

U.S. Cotton Traceability

Learn about what makes U.S. cotton stand out from the rest with 100% traceability.

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Please take our brief survey on today's presentation prior to exiting the webinar.