ADVANCED WATER STRESS INDEX (WSI)

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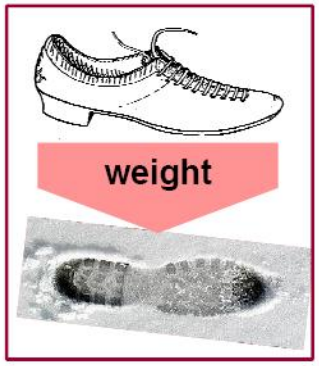
WSI - what for?

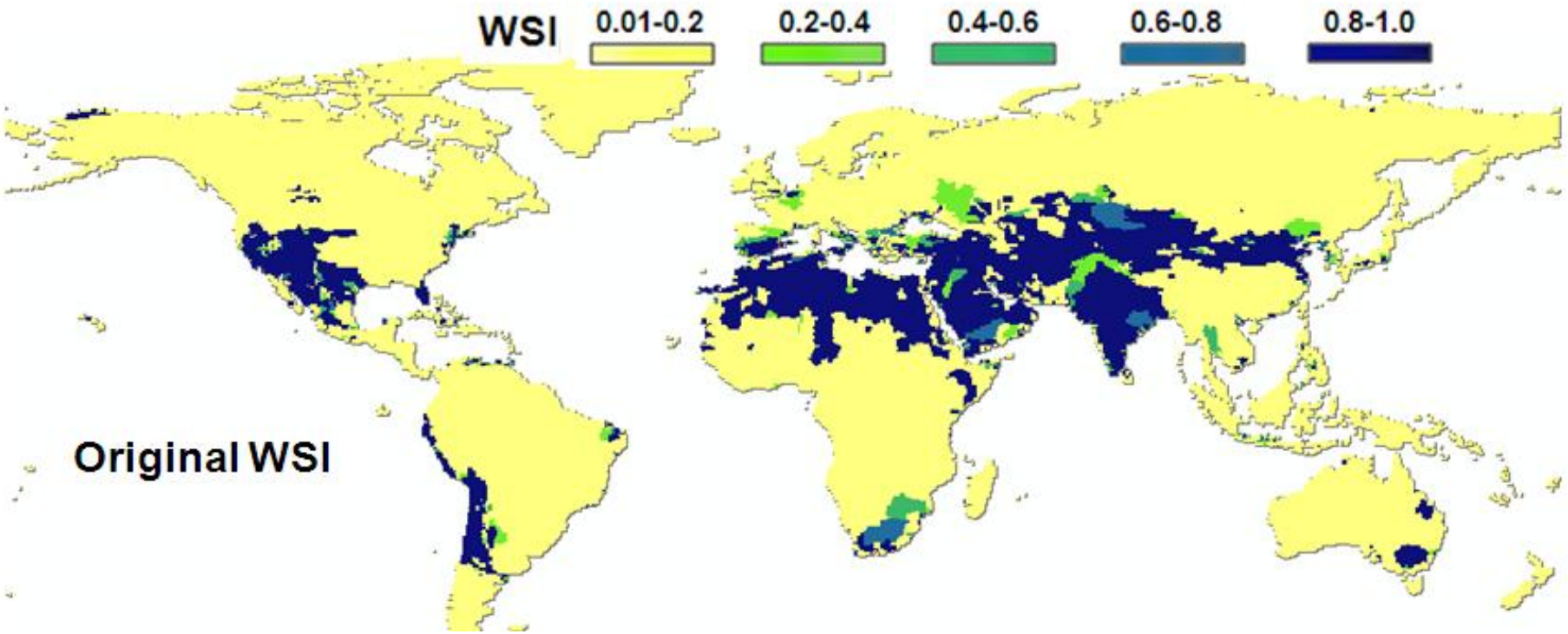
- Water footprint



- Water midpoint assessment in LCA

- Water scarcity/risk mapping tools:
  - http://growingblue.com/the-growing-blue-tool/
  - http://waterriskfilter.panda.org/Maps.aspx

WSI (Pfister et al. 2009)



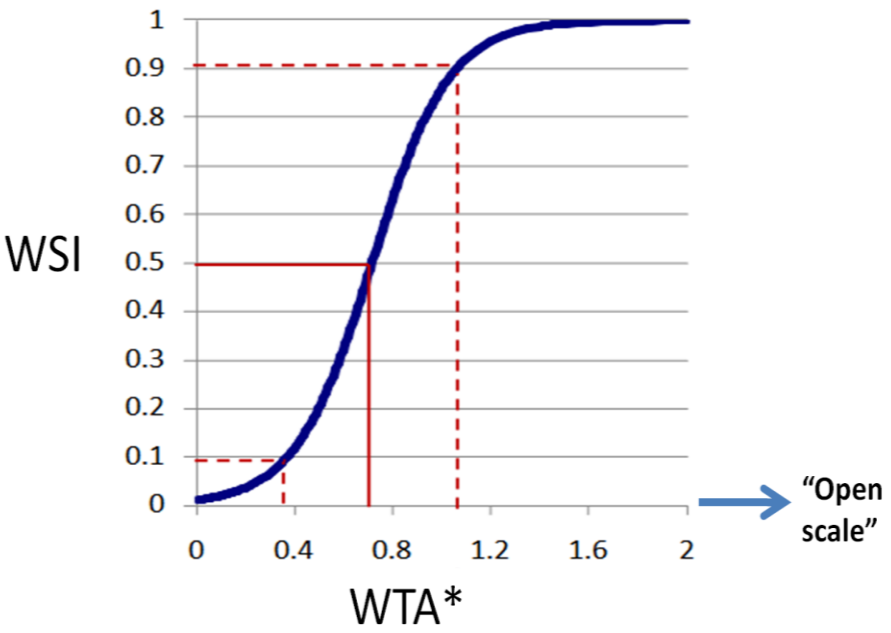
What's behind: Water Stress Index (WSI)

- **Includes**:
  - Withdrawal to availability (WTA)
  - Variability in precipitation (VF)
  - Flow regulation (highly regulated = SRF)

$$WTA^{*} = \begin{cases} \sqrt{VF} \times WTA & for\ SRF \\ VF \times WTA & for\ non\text{-}SRF \end{cases}$$

- **Index** following logistic function:

$$WSI = \frac{1}{1 + e^{-6.4 \cdot WTA^{*}} \left(\frac{1}{0.01} - 1 \right)}$$



Issues

- Hydrological background data and models
  - Old data: ref. year 1995
  - Old model: 2003

- Annual resolution
- No distinction of ground and surface water

- Overall uncertainties

Related uncertainties

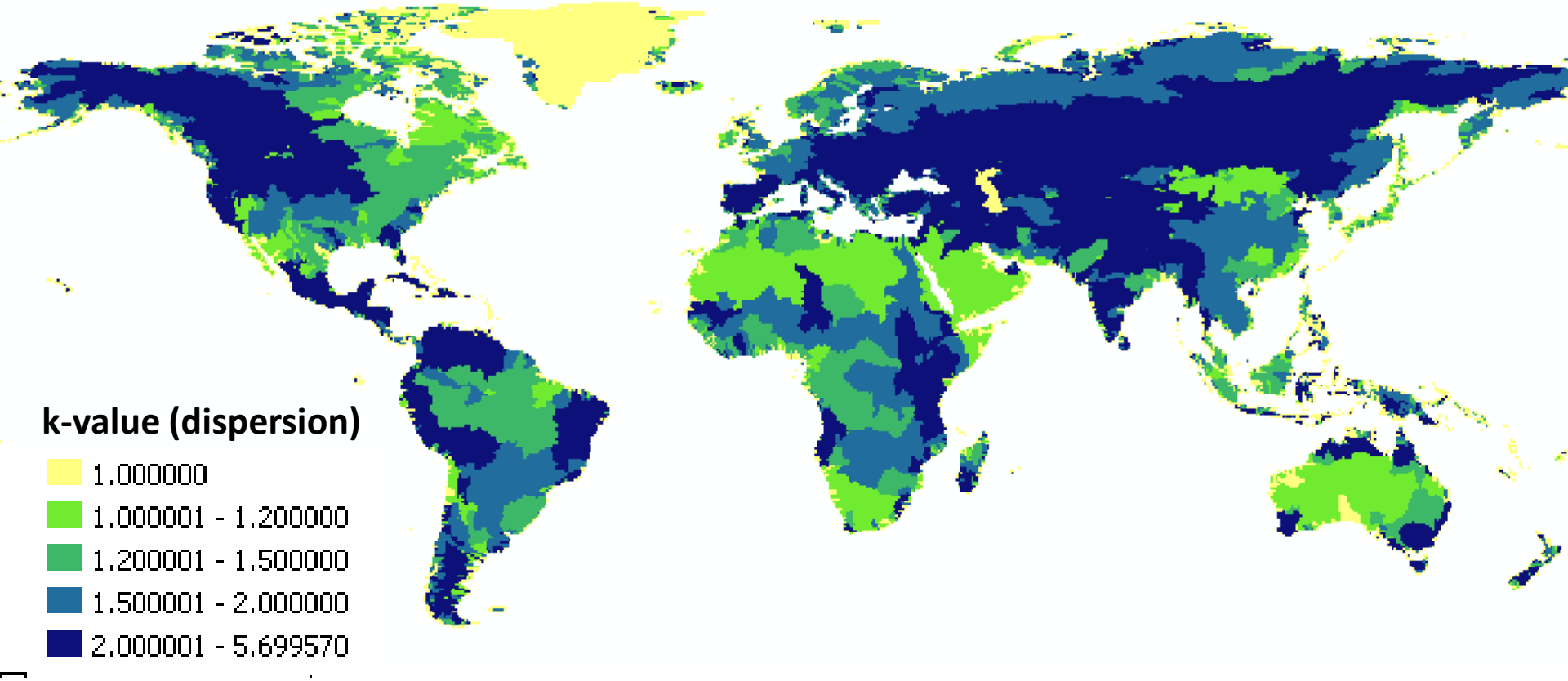
Impact assessment model step	Function	Parameters	k-value / Uncertainty function	Main source for uncertainty
Withdrawal to availability ratio (WTA)				
		Availability	GIS model	Based on Fekete et al. (2004)
		Withdrawals	HDI function	Based on Alcamo et al. (2003)
Water Stress Index (WSI)				
		VF-exponent	Binominal distribution (80/20%,)	Assumption of data accuracy
	WTA* function		VF	Precipitation distribution analysis
	WSI function		1.7	Assumption considering the logistic function

Details: http://www.ifu.ethz.ch/ESD/downloads/Uncertainty_water_LCIA.pdf

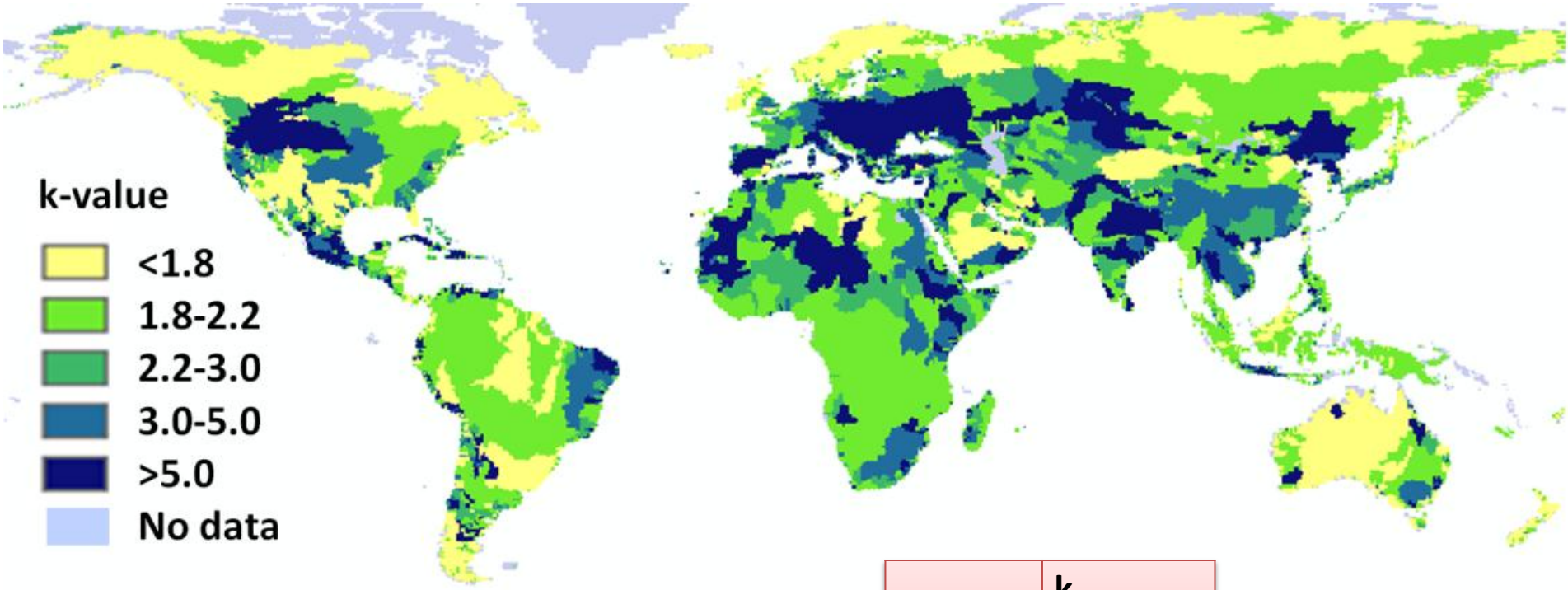
LC-IMPACT

Related uncertainties: availability

Impact assessment model step	Function	Parameters	k-value / Uncertainty function	Main source for uncertainty
Withdrawal to availability ratio (WTA)				
		Availability	GIS model	Based on Fekete et al. (2004)



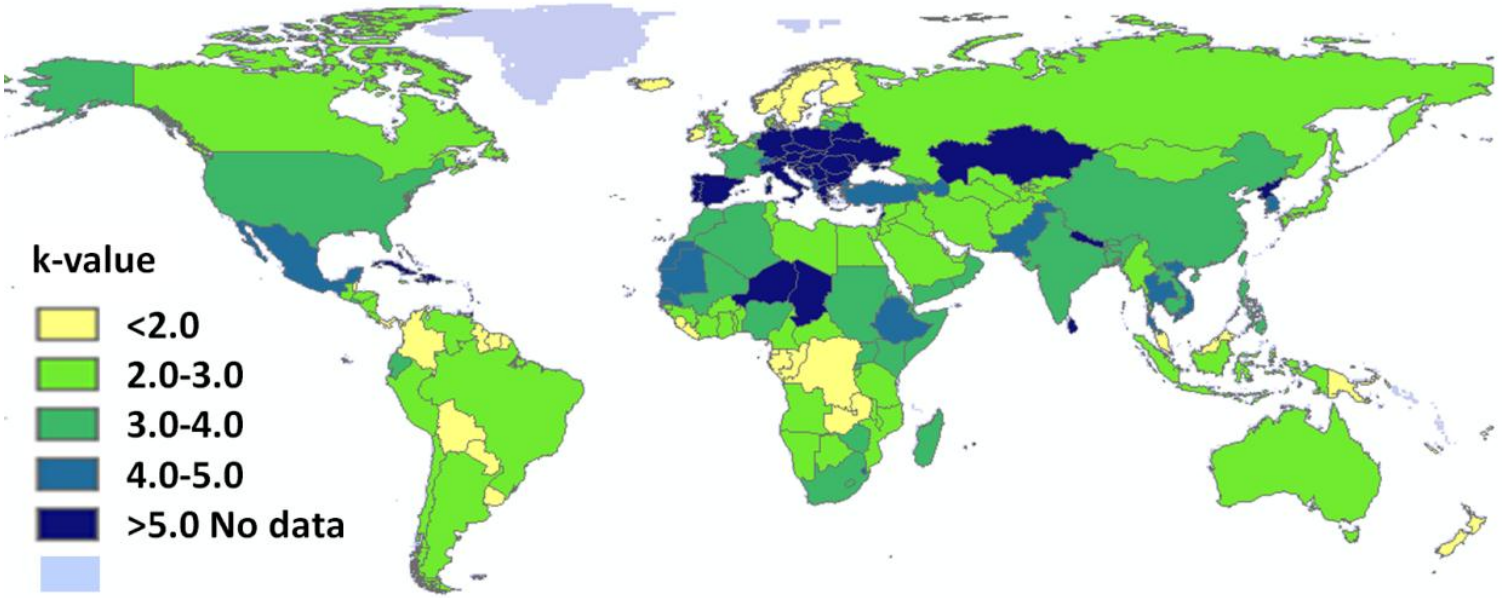
Related uncertainties: WSI



	k_{WSI}
Average	2.76
Min	1.68
Max	12.20

Uncertainty due to aggregation (Variability)

k-value caused by the **aggregation** of watershed to country resolution for **midpoint**



Report: http://www.ifu.ethz.ch/ESD/downloads/Uncertainty_water_LCIA.pdf

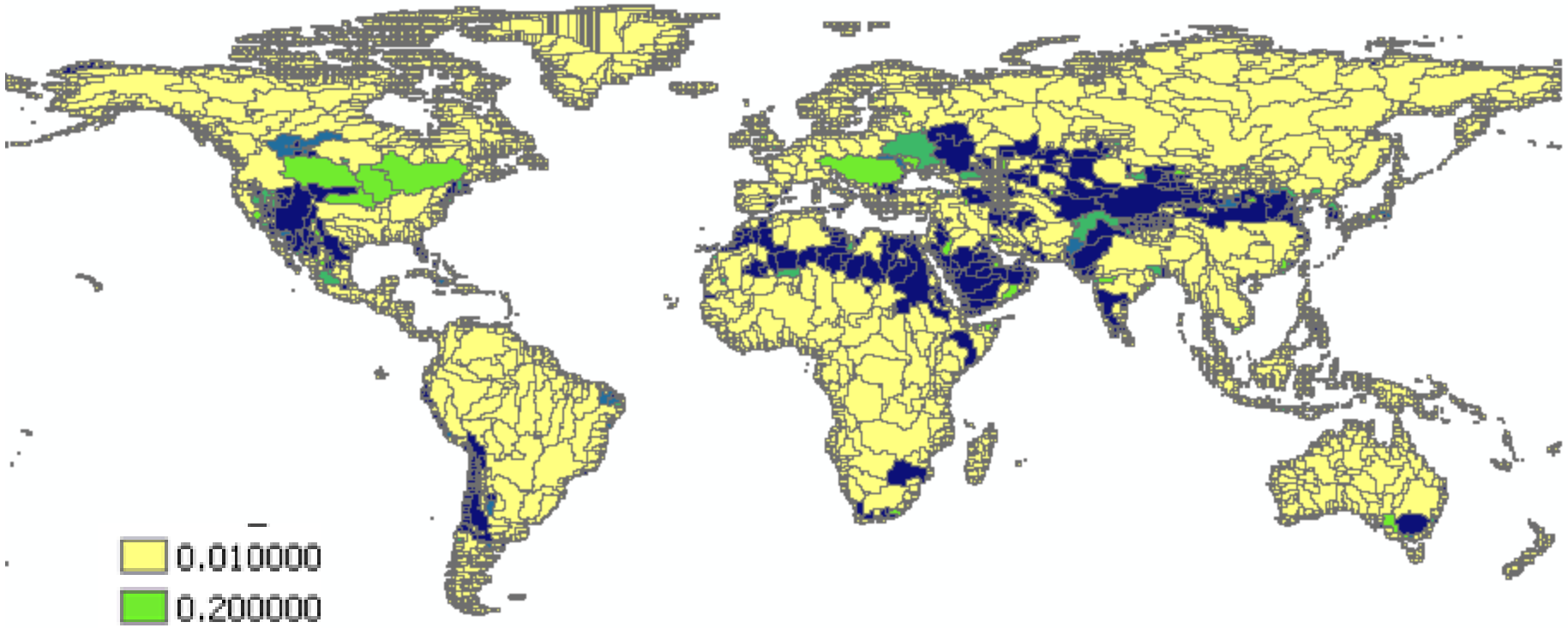
Combining monthly and annual data

- Water Gap 2 annual model (Alcamo et al. 2003)

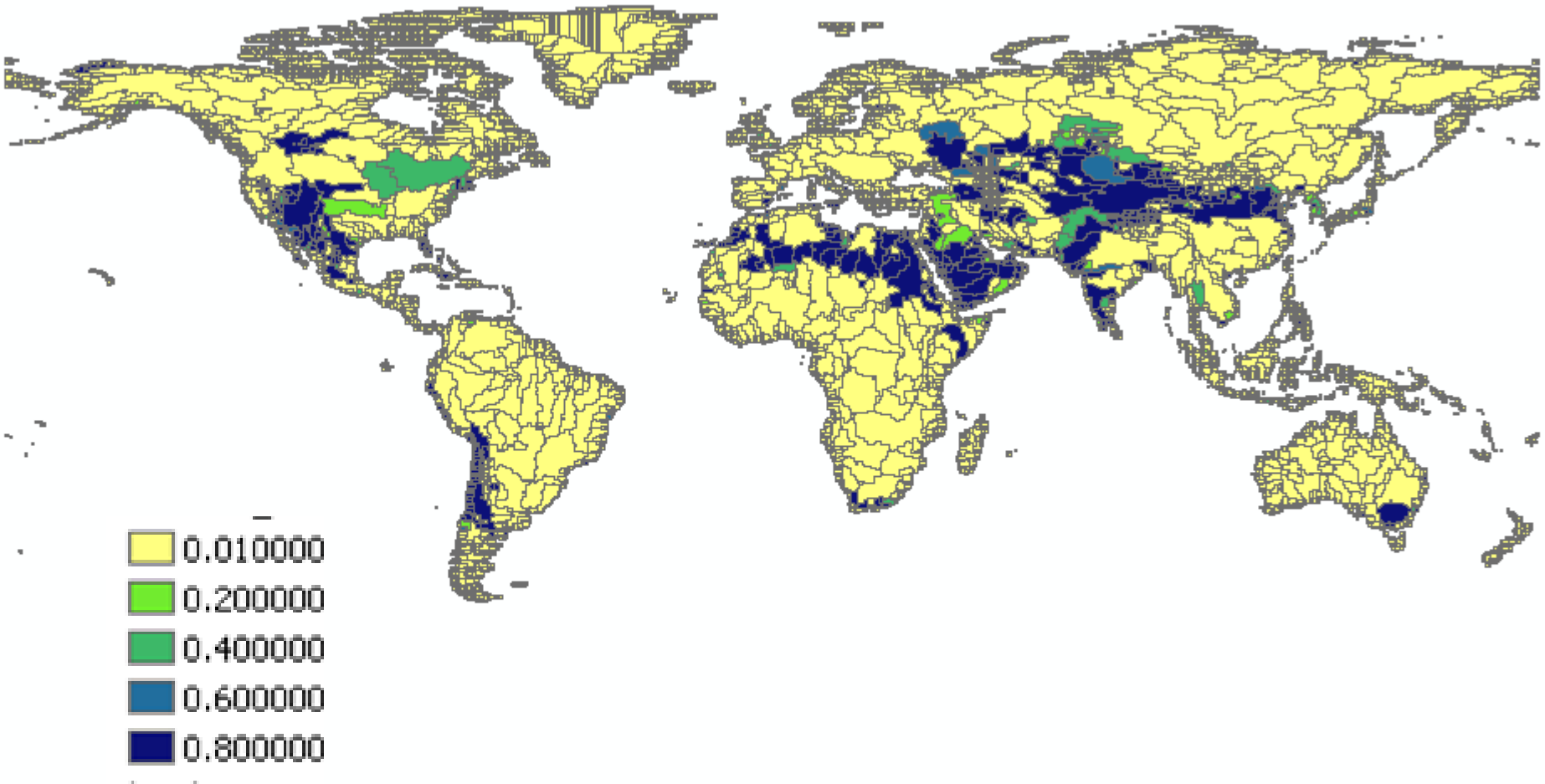
- Monthly use-to-availability ratios
  - Vorosmarty et al. (2000) for the year 1995 on 0.5 Arc min resolution)

Details:
http://www.ifu.ethz.ch/ESD/downloads/Monthly_WSI/reports/Monthly_WSI_LCA_FOOD.pdf

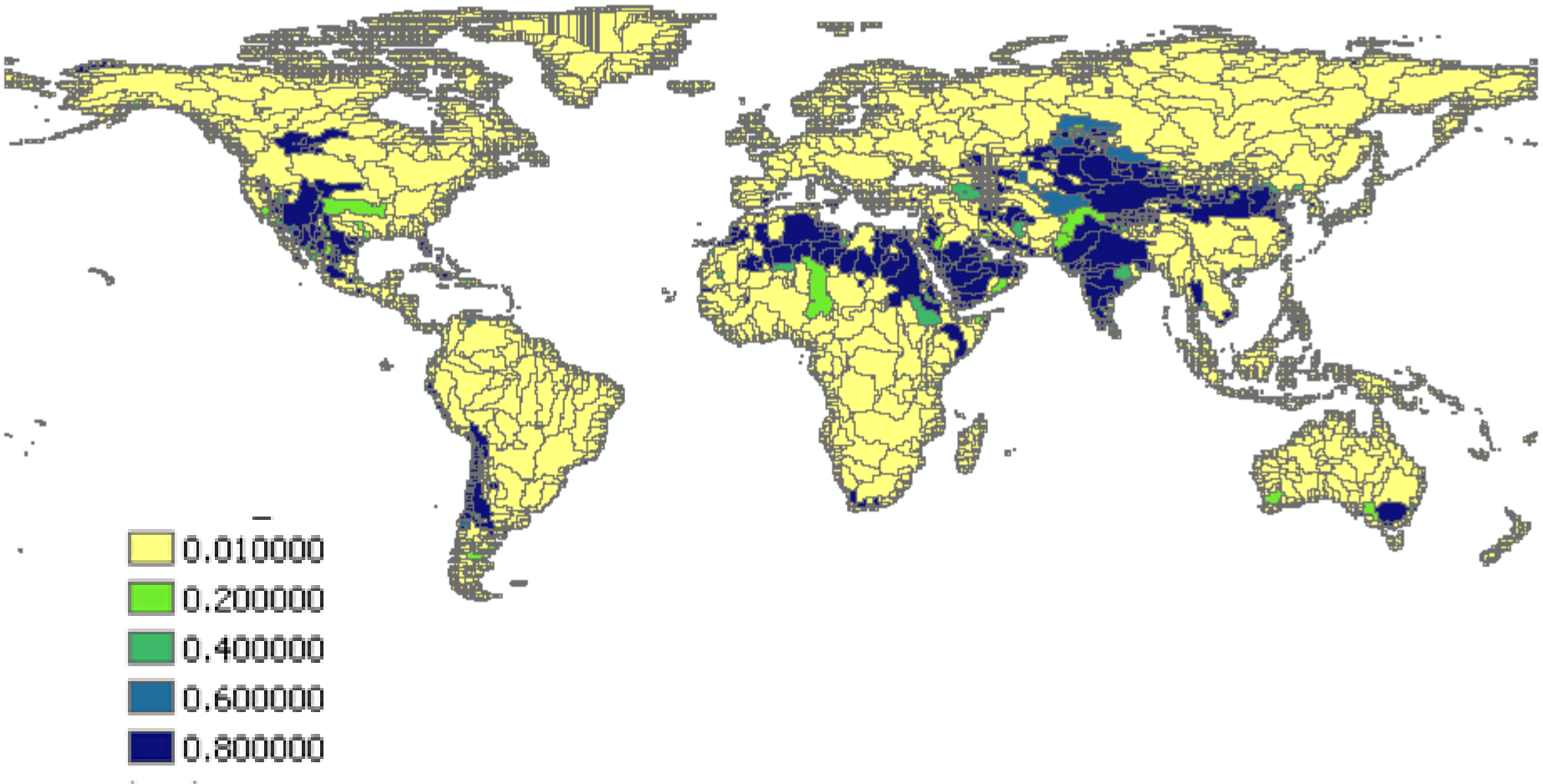
WSI January



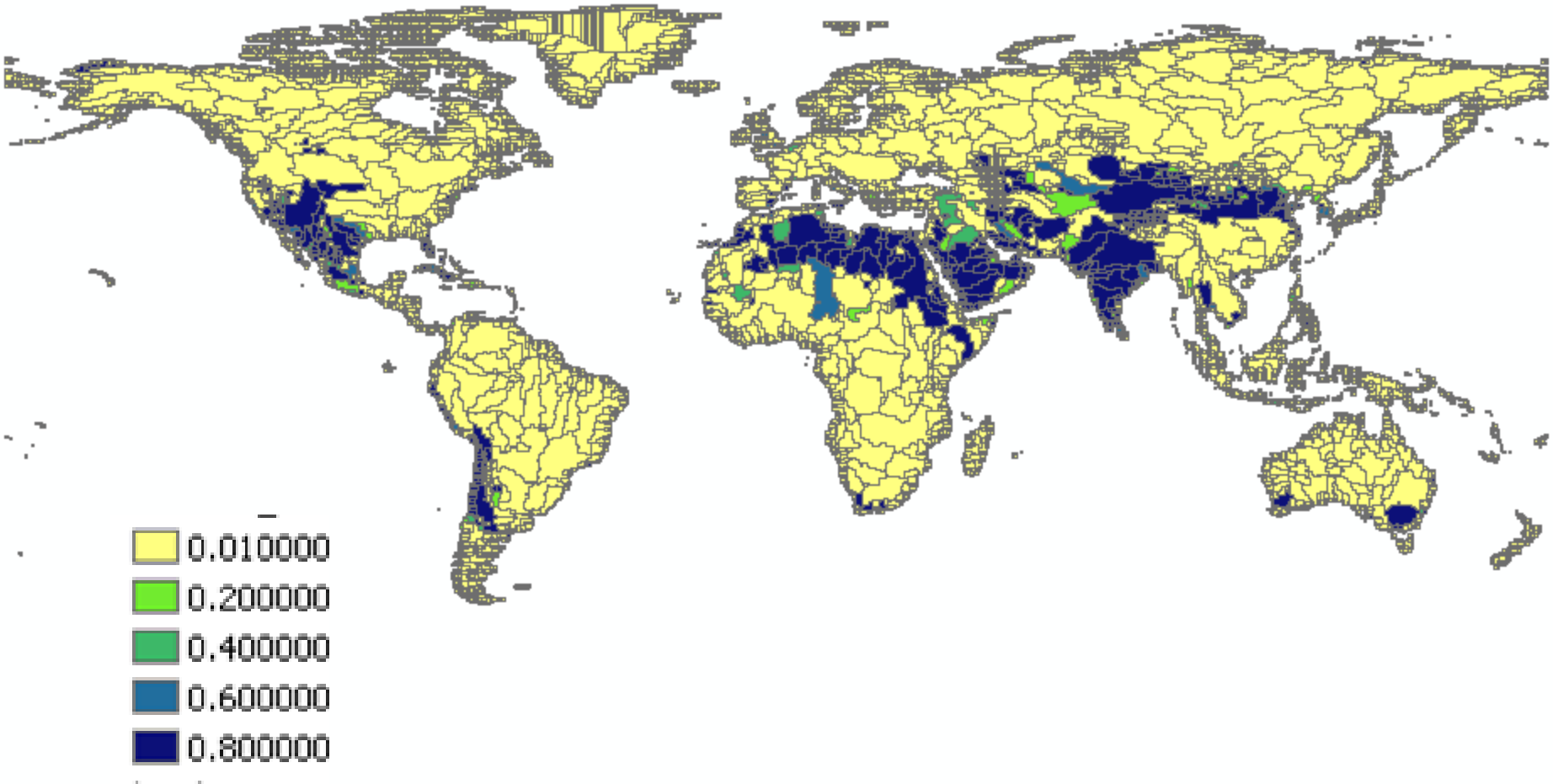
WSI February



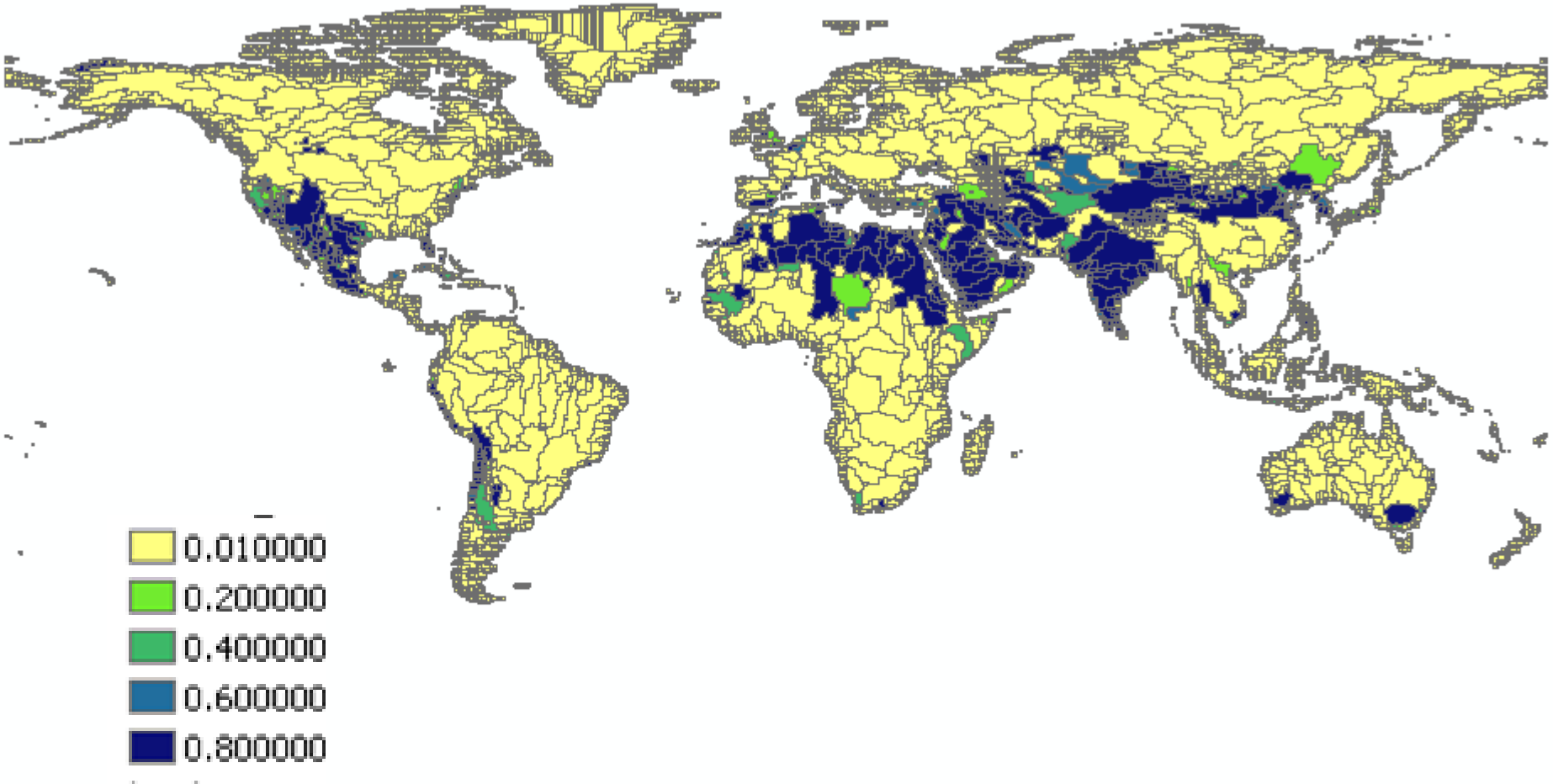
WSI March



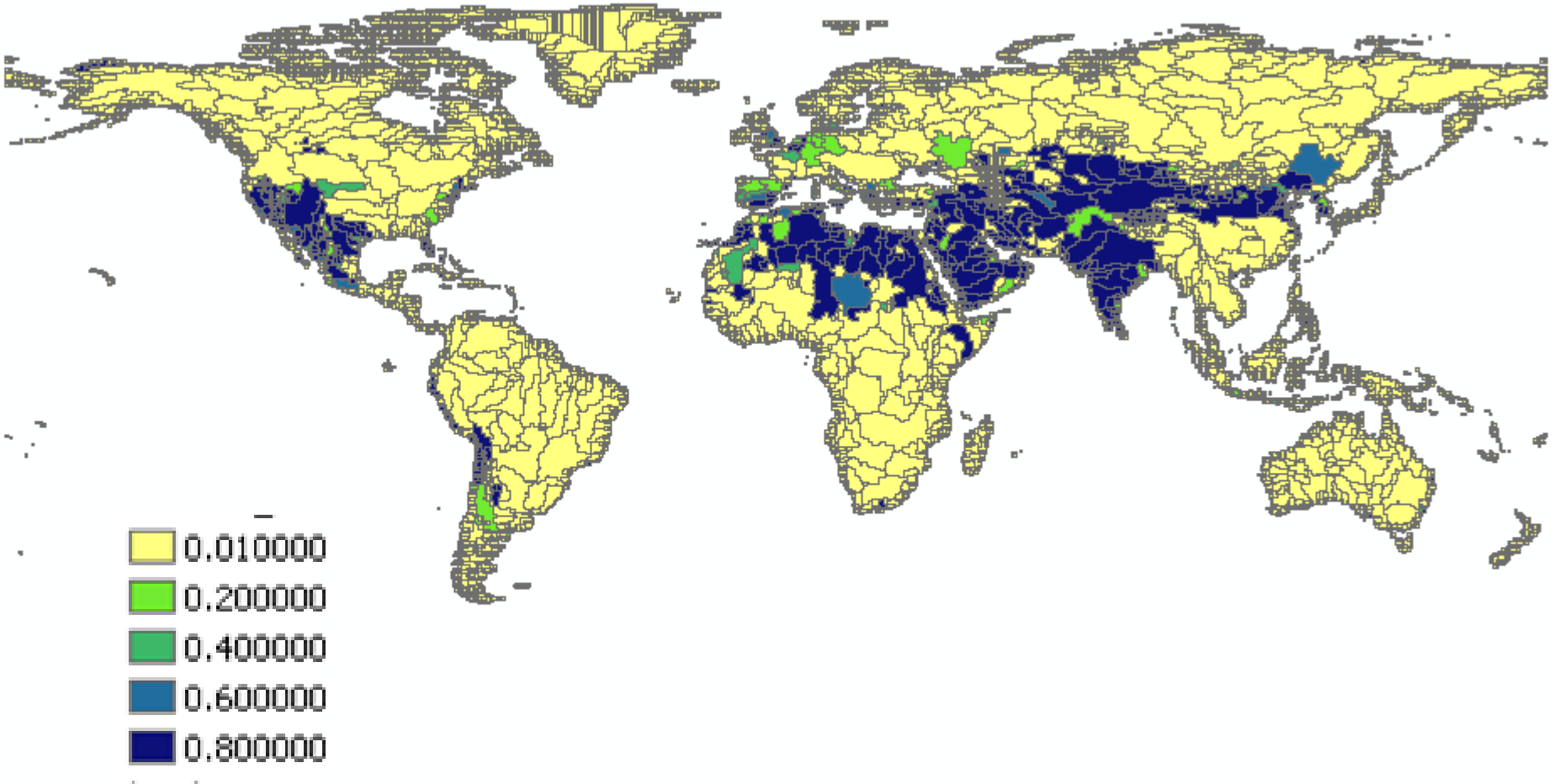
WSI April



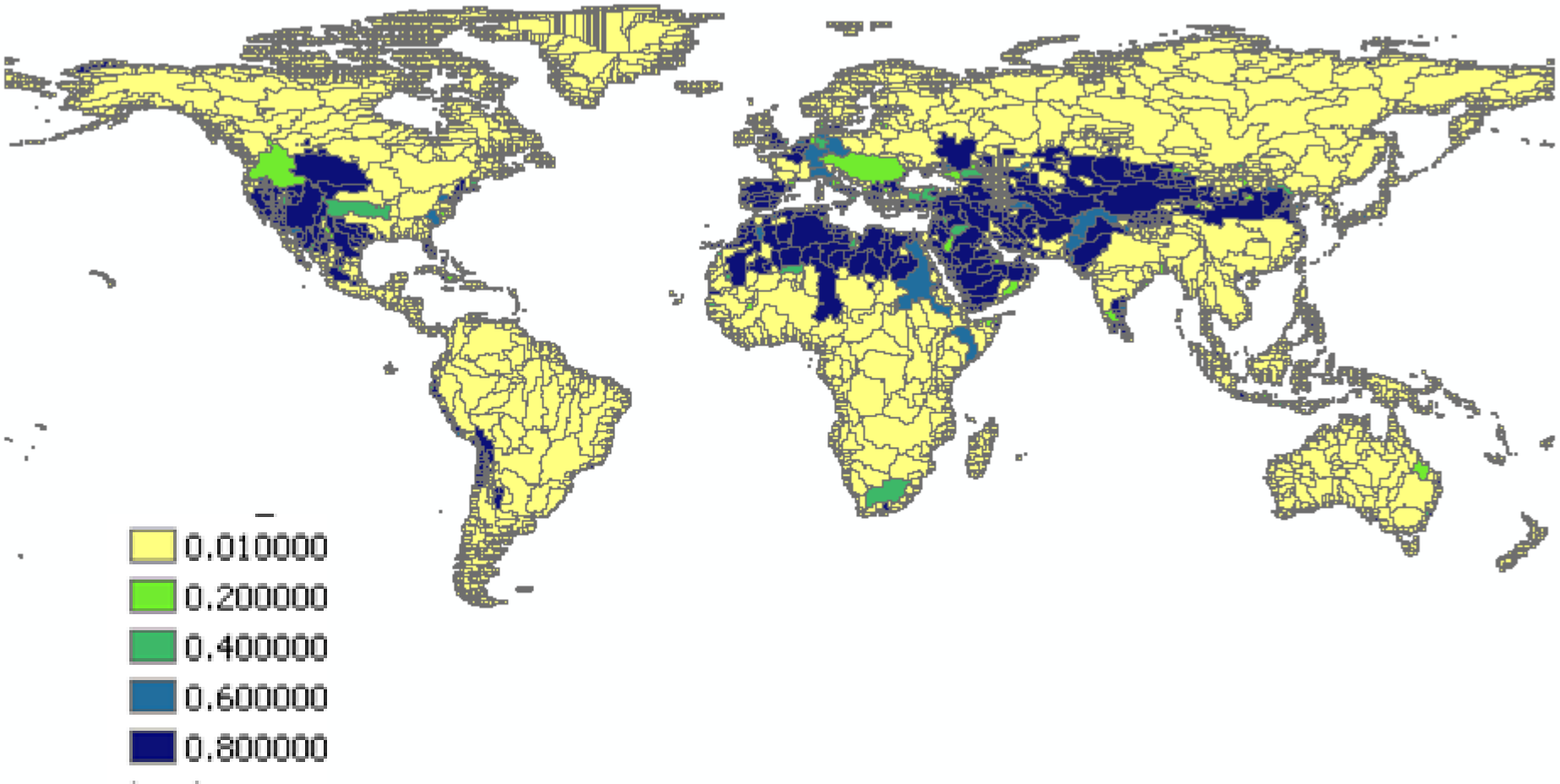
WSI May



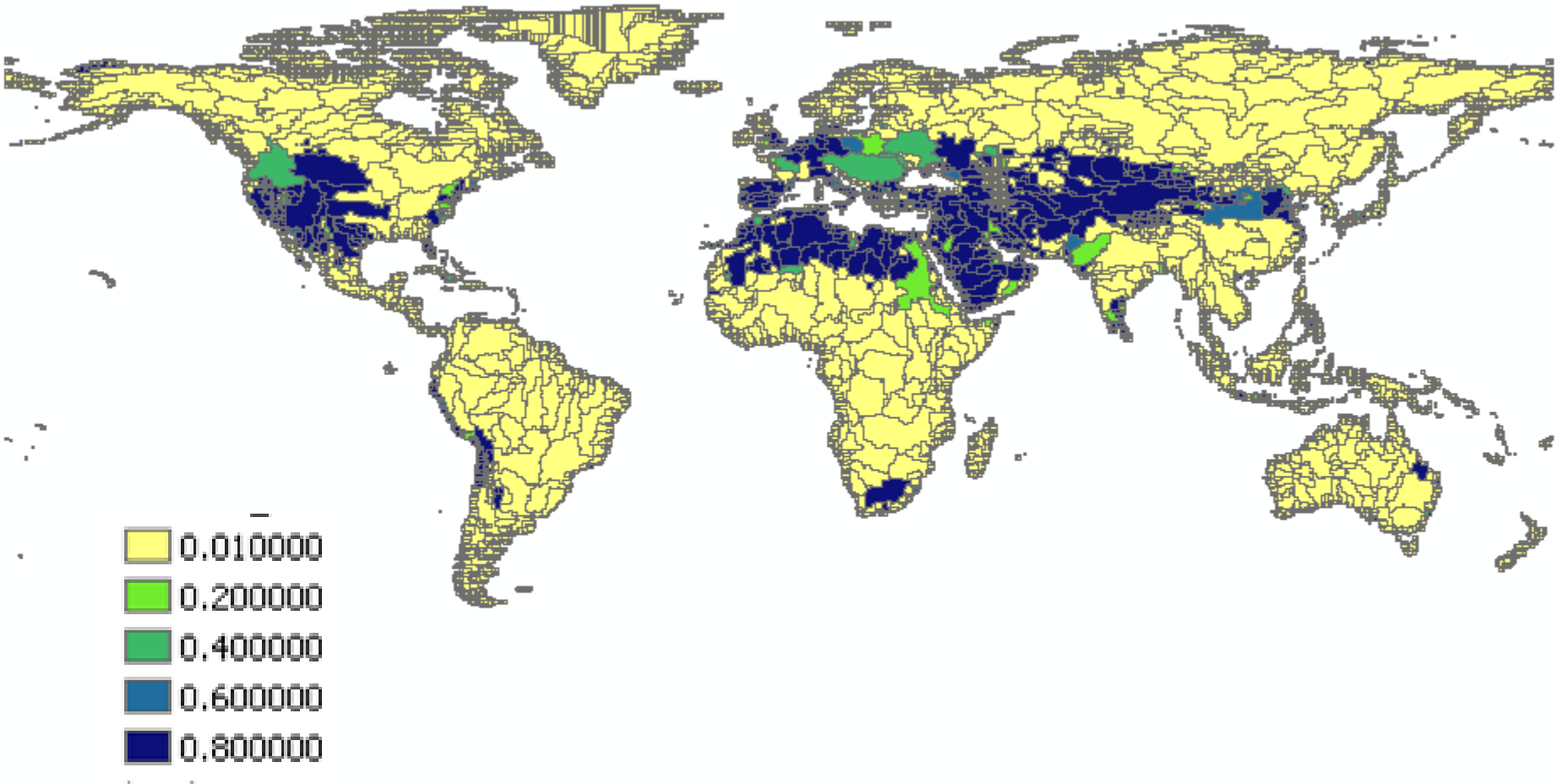
WSI June



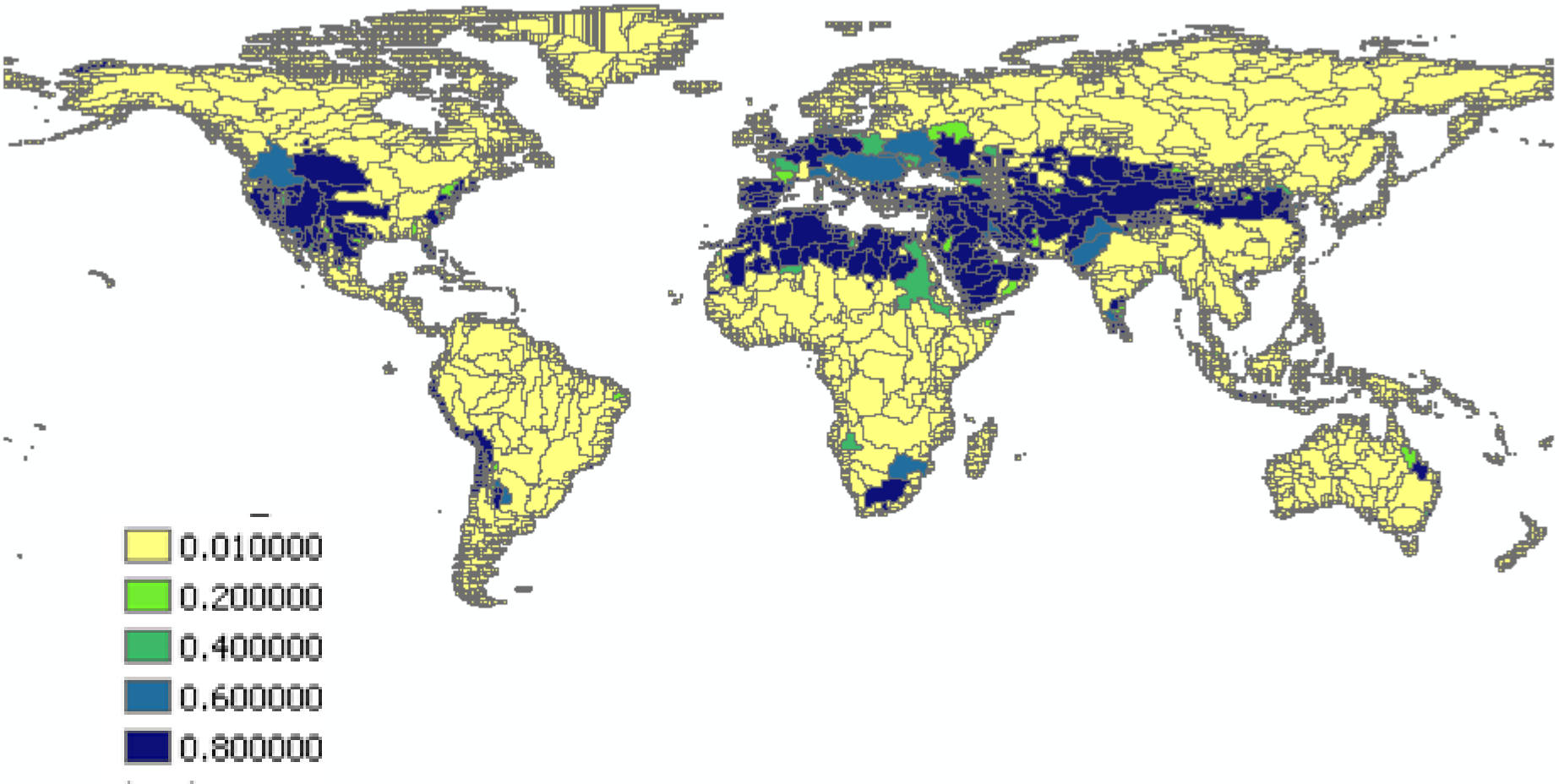
WSI July



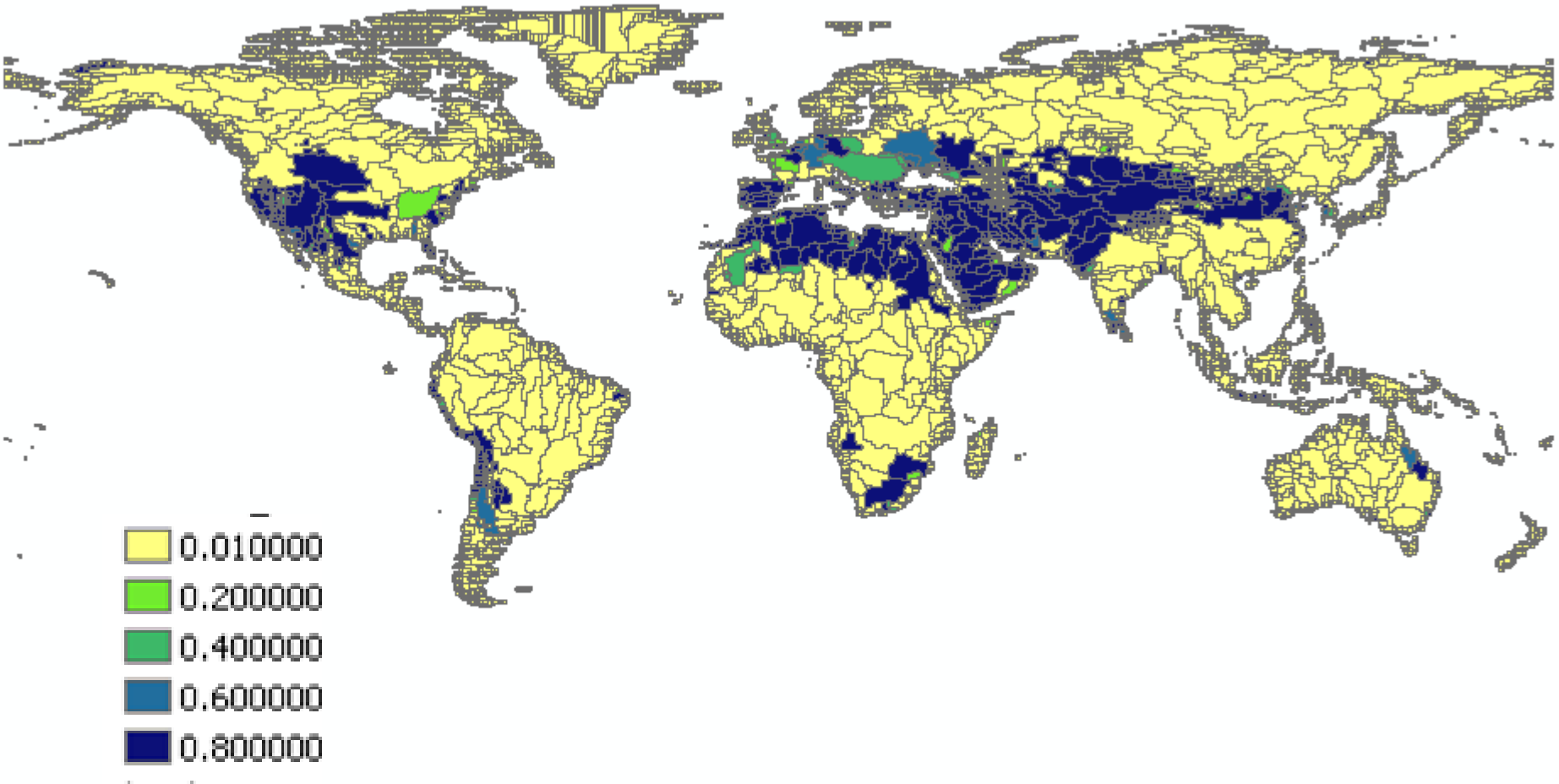
WSI August



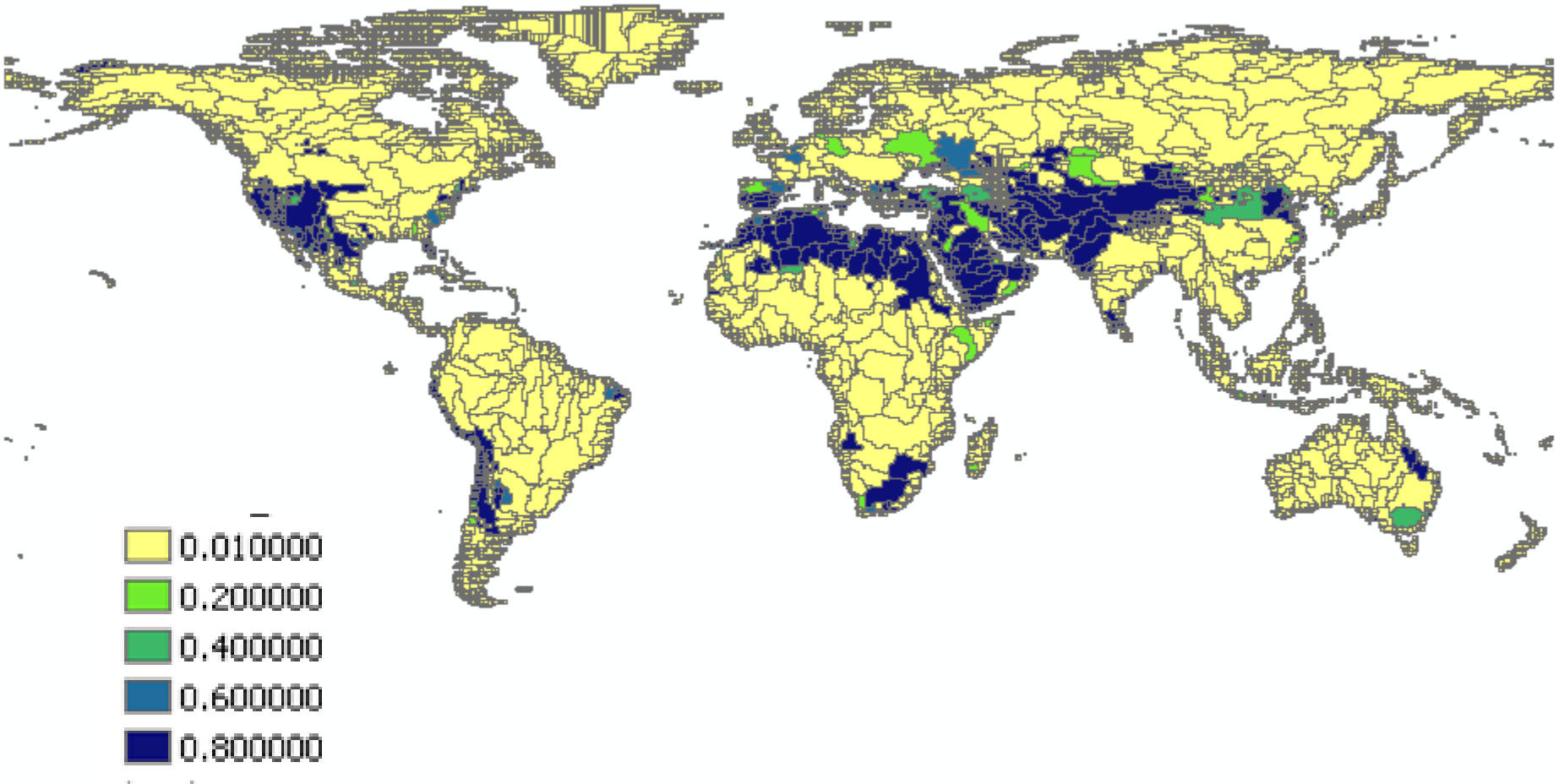
WSI September



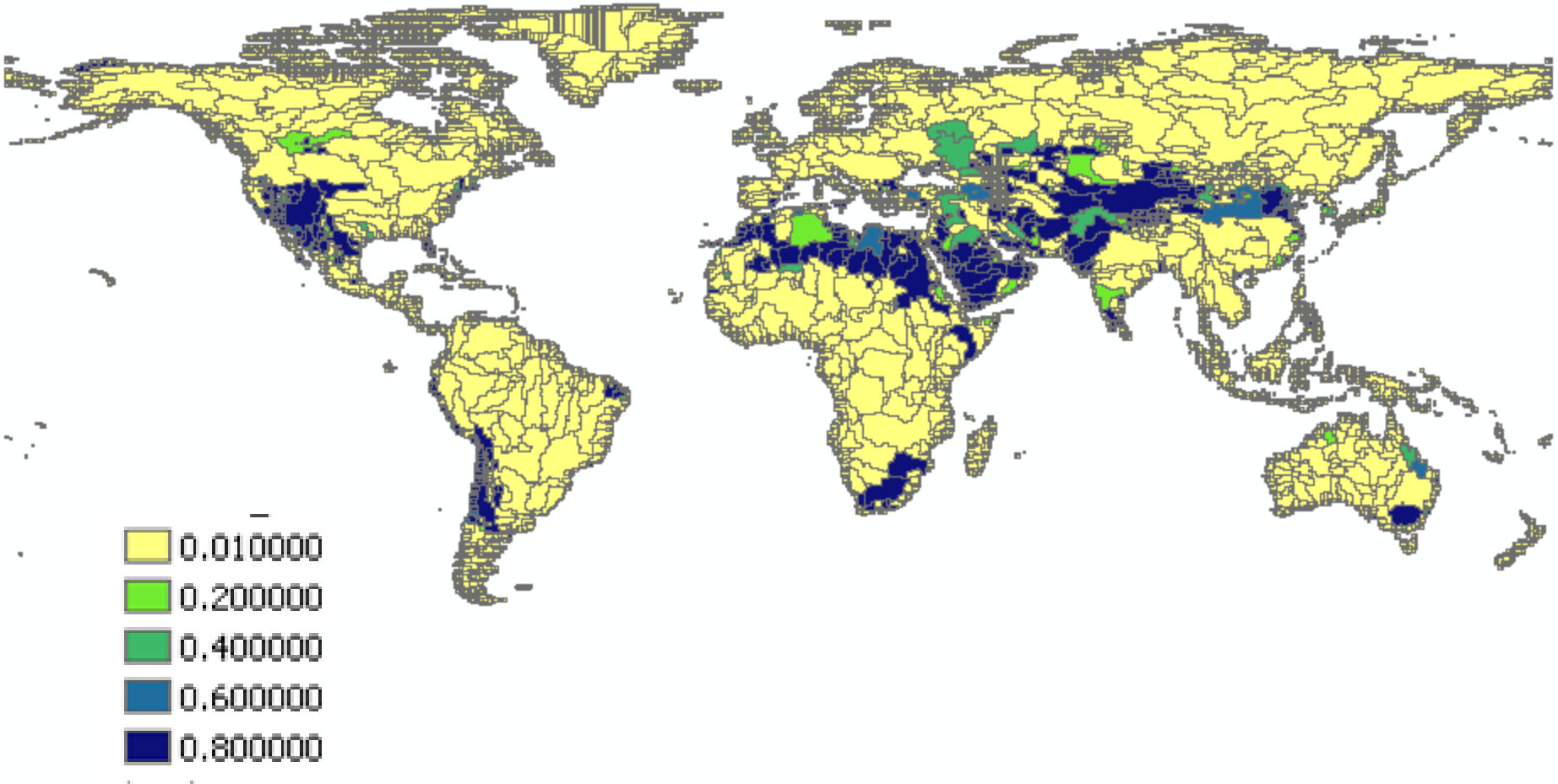
WSI October



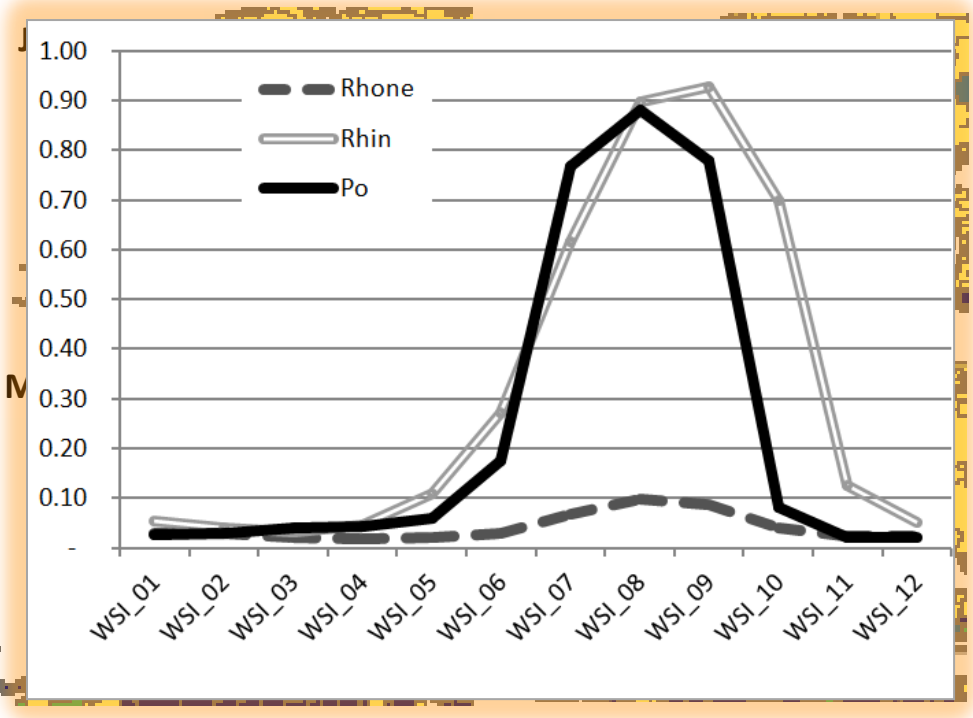
WSI November

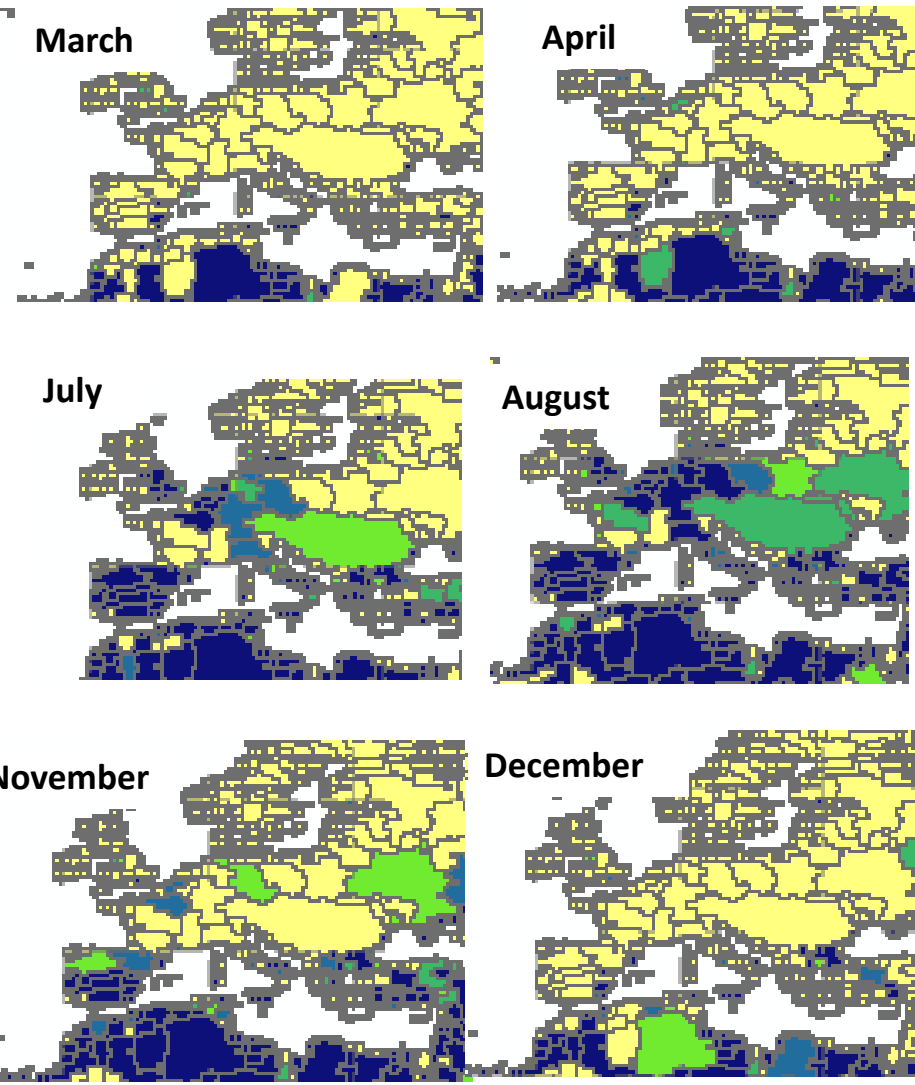


WSI December

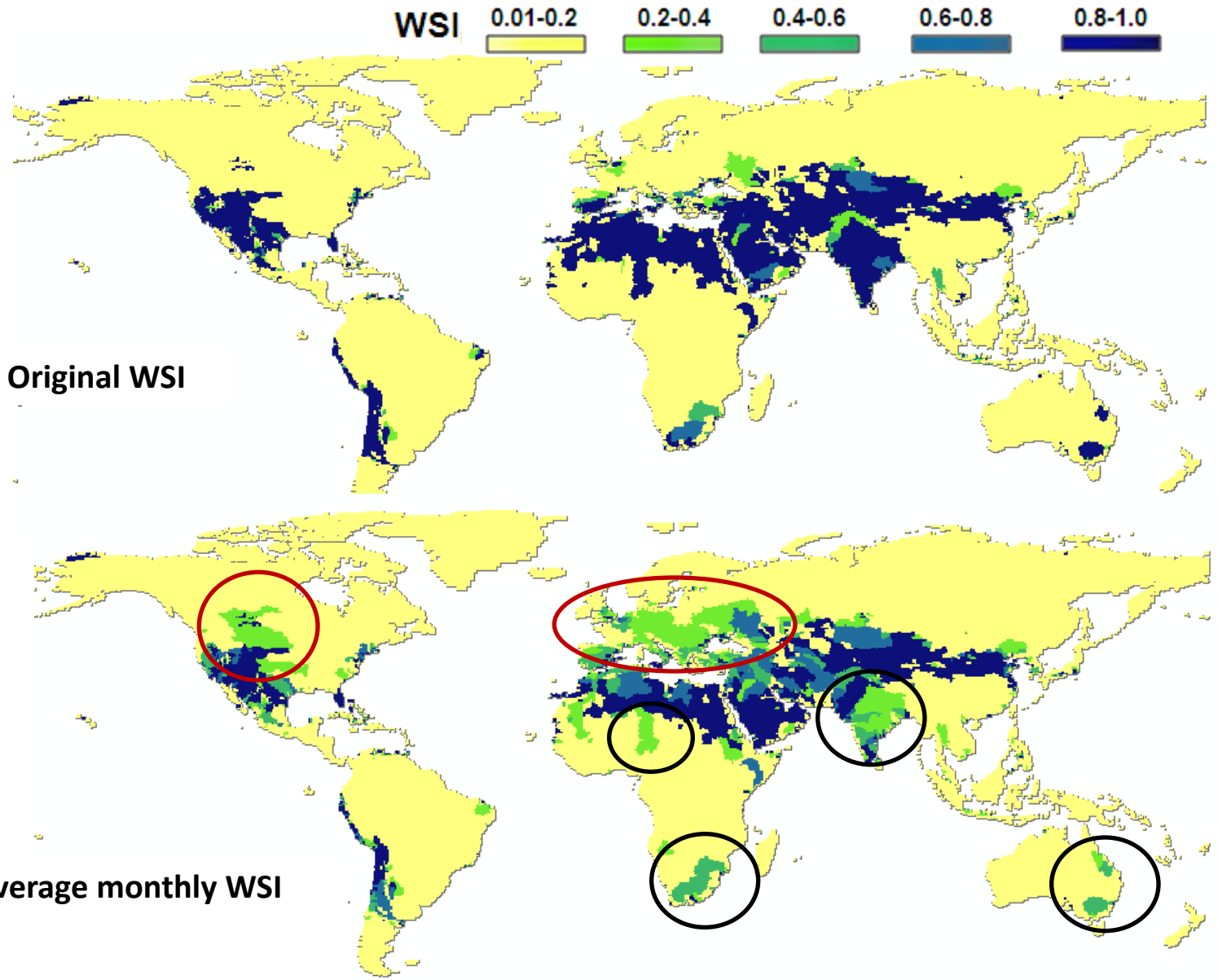


Europe


1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
-
Rhone
Rhin
Po
WSI_01
WSI_02
WSI_03
WSI_04
WSI_05
WSI_06
WSI_07
WSI_08
WSI_09
WSI_10
WSI_11
WSI_12

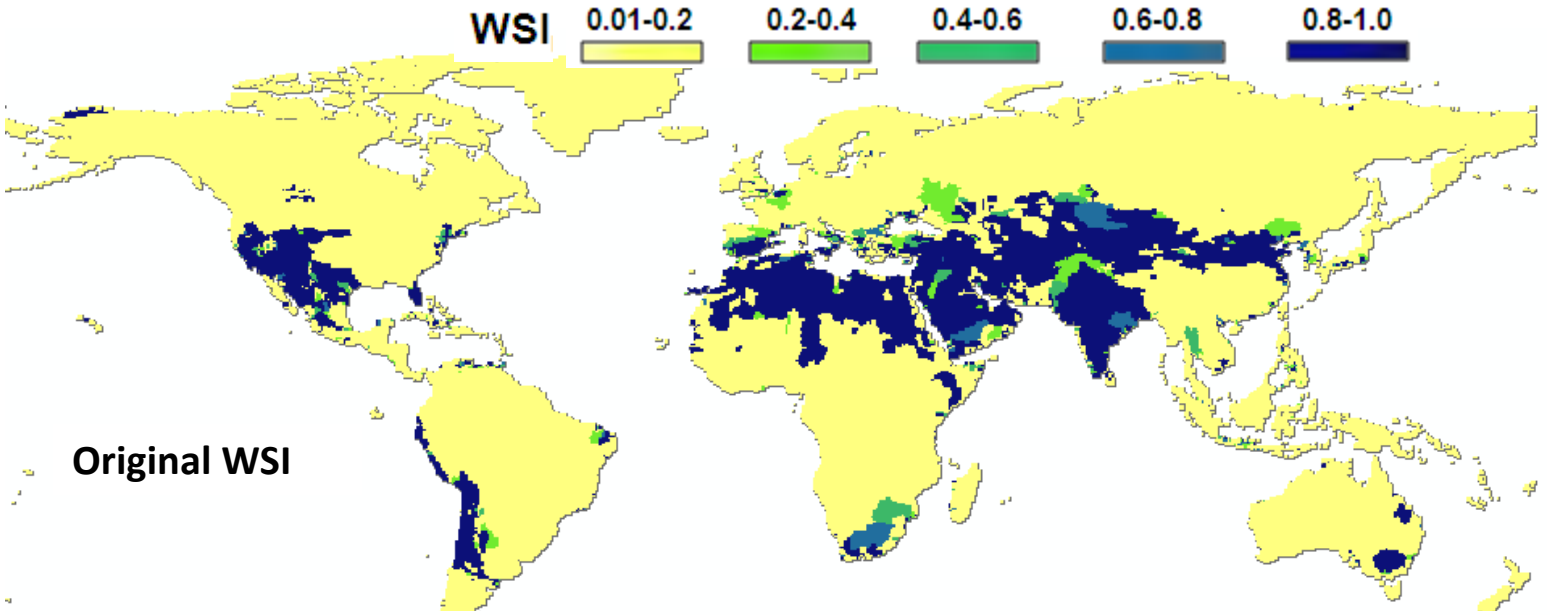

WSI monthly
0.01-0.2
0.2-0.4
0.4-0.6
0.6-0.8
0.8-1.0
March
April
July
August
September
October
November
December

Average monthly vs. annual WSI

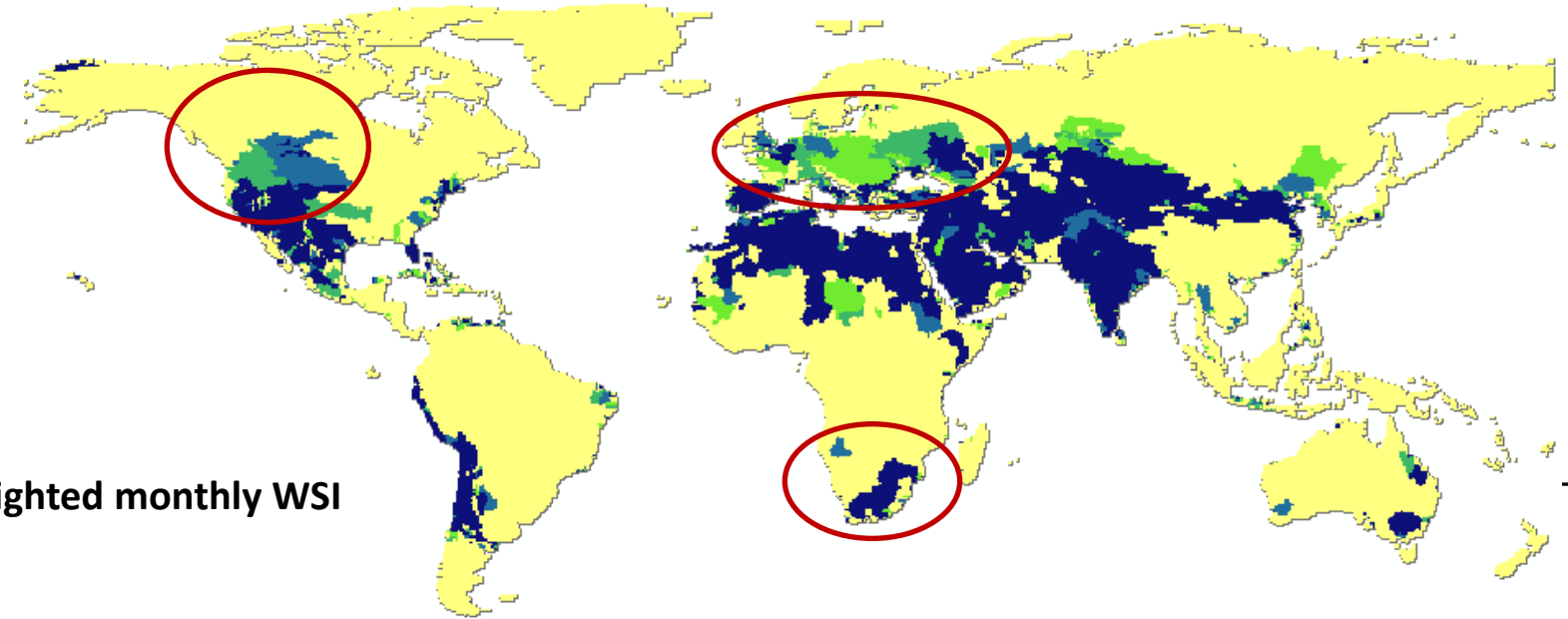


ESD
ecological systems design

Weighted monthly vs. annual WSI



Original WSI

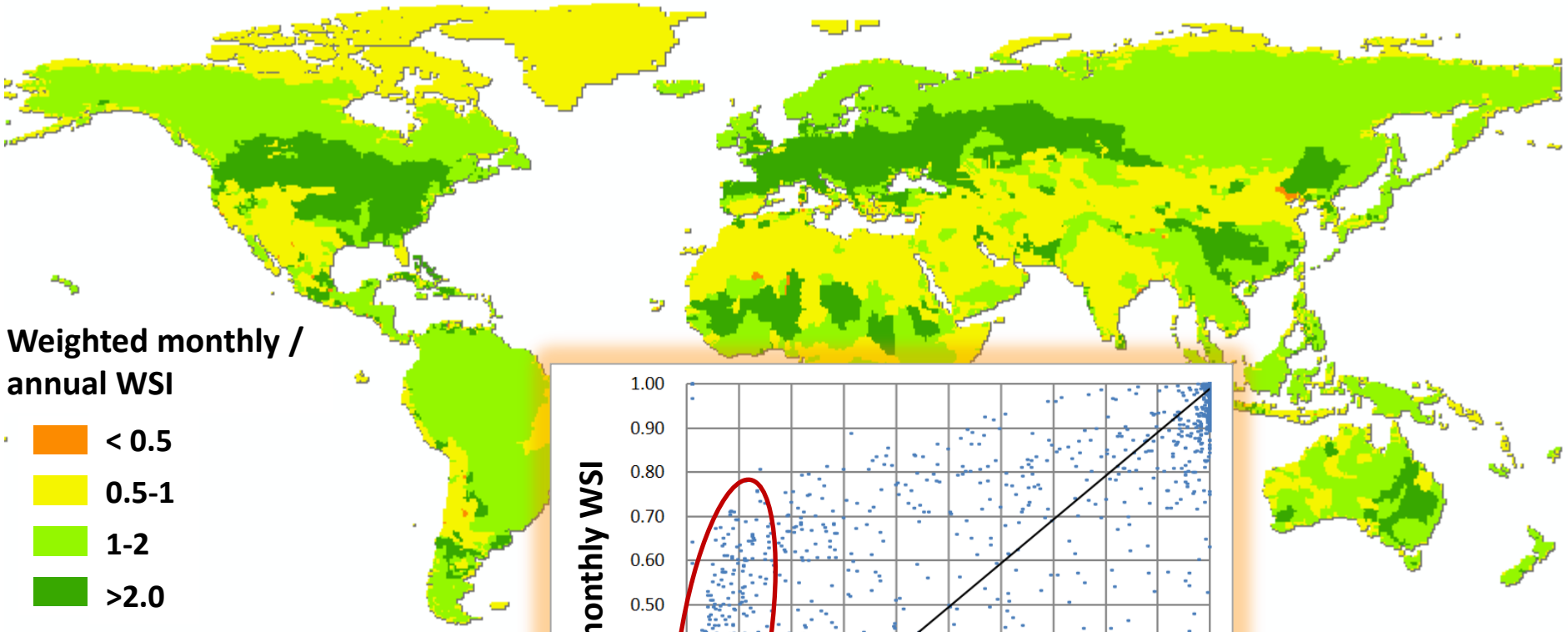


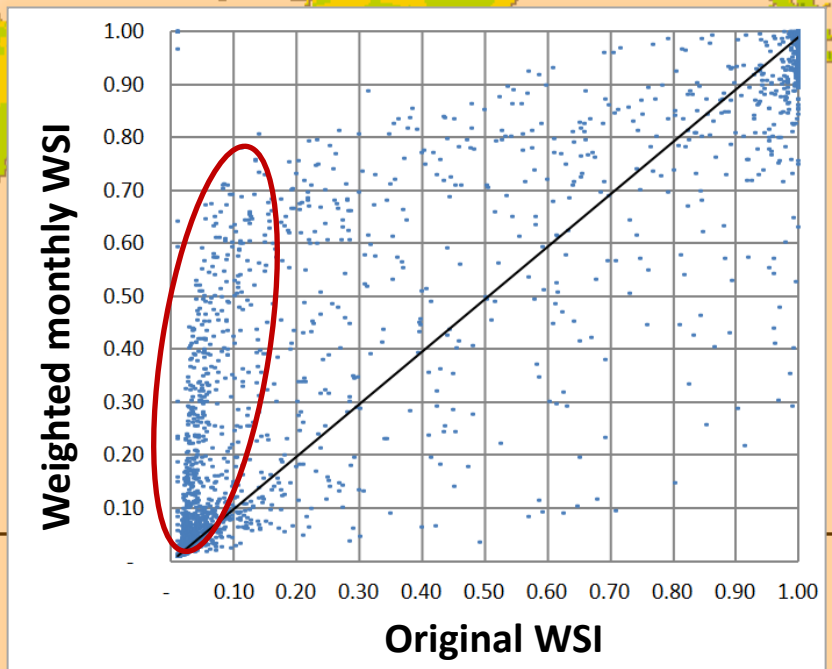
Weighted monthly WSI

ESD
ecological systems design

Ratio weighted monthly vs. annual WSI

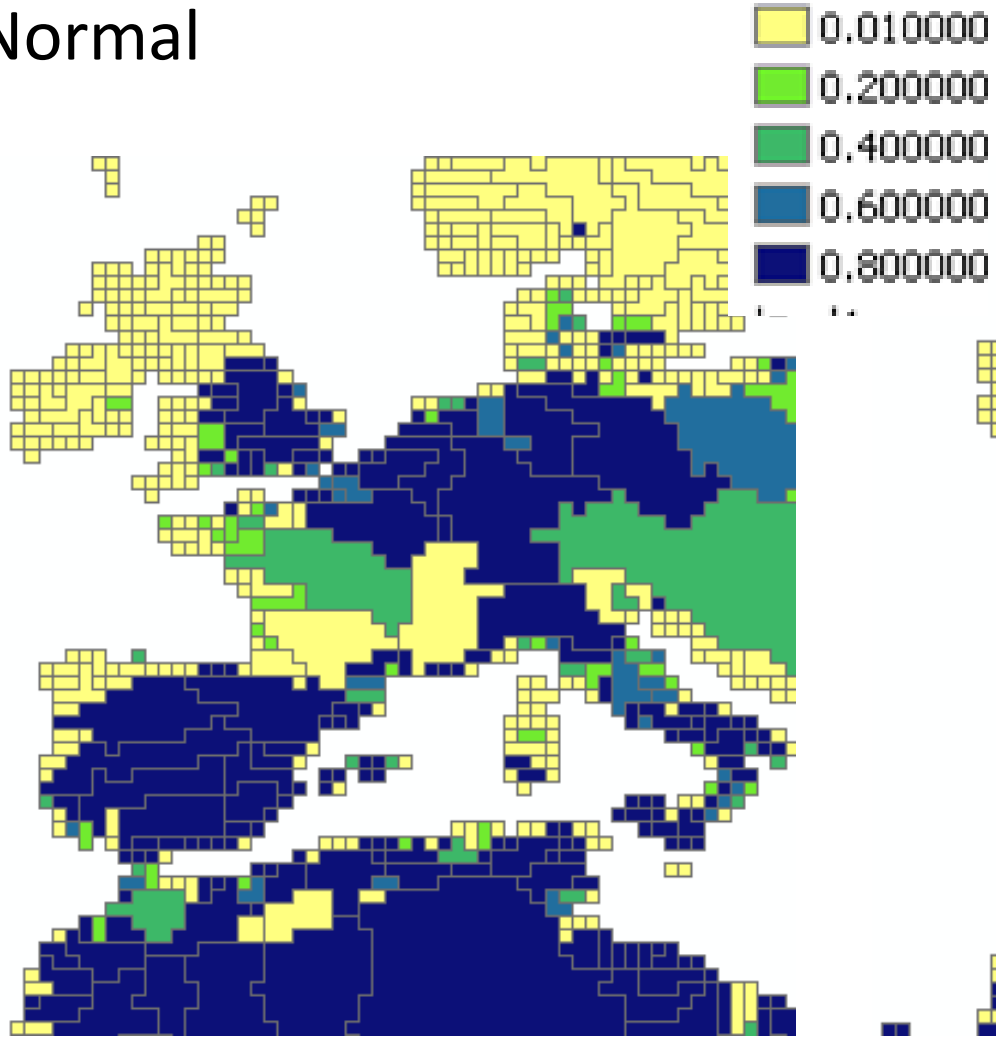
- Monthly resolution reveals higher stress in many watersheds



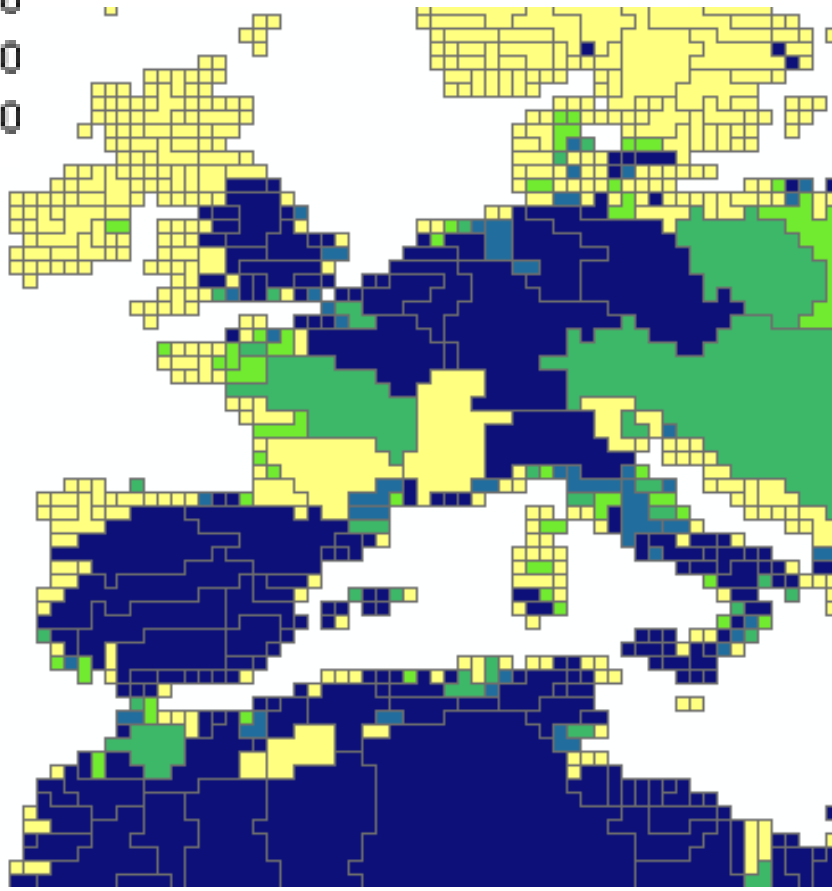


Moving average (August example)

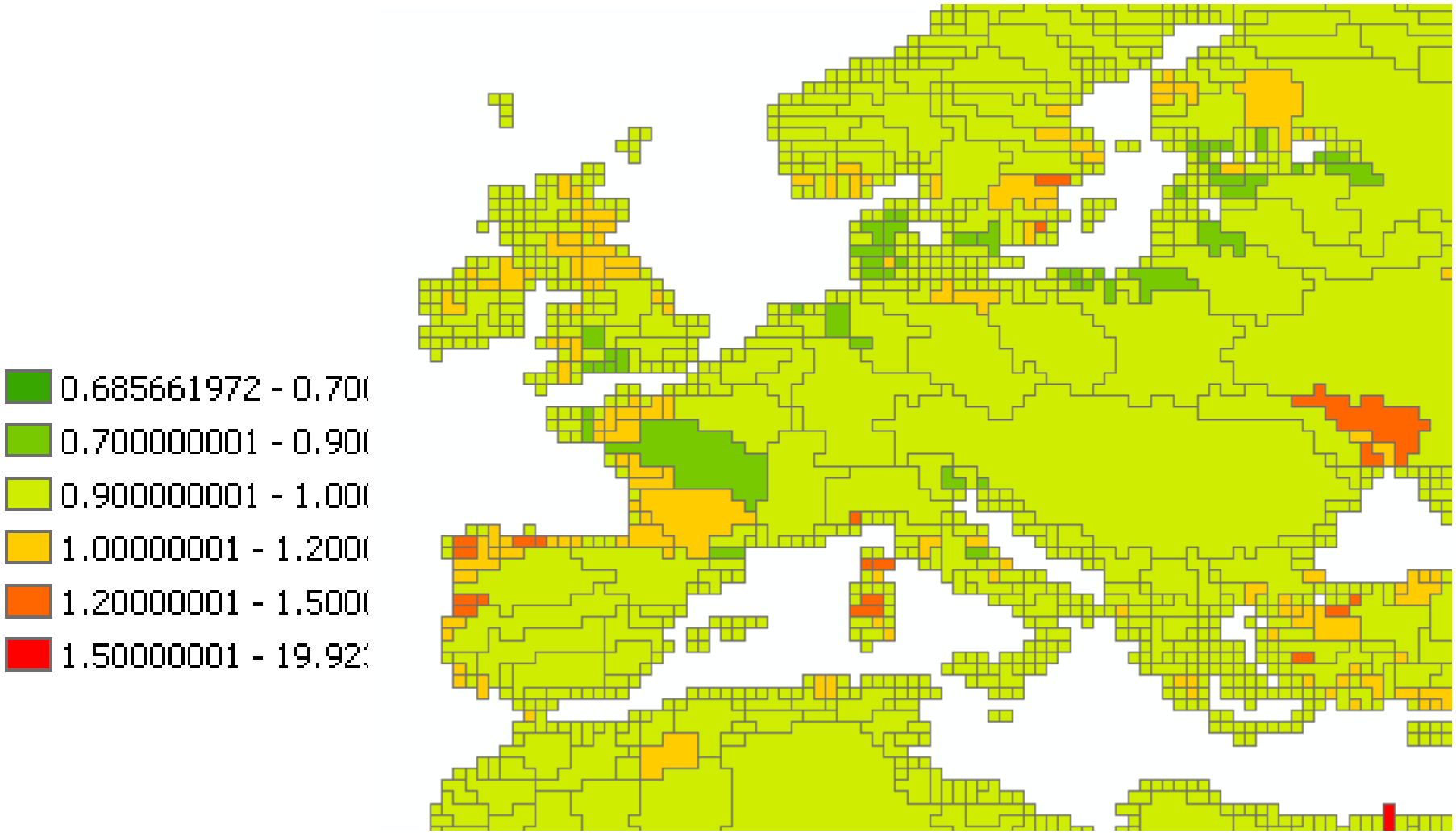
Normal



(i-1) + (3* i) + (i+1)



Ratio moving / normal (august)



To be included for monthly WSI

- Storage effects
  - Dams
  - Groundwater
- Withdrawal vs. consumption based WSI
  - Use adds to pressure
- Water source (ground surface water)
  - Different characteristics
- Spatial & temporal resolution induced uncertainty
  - Aggregated datasets

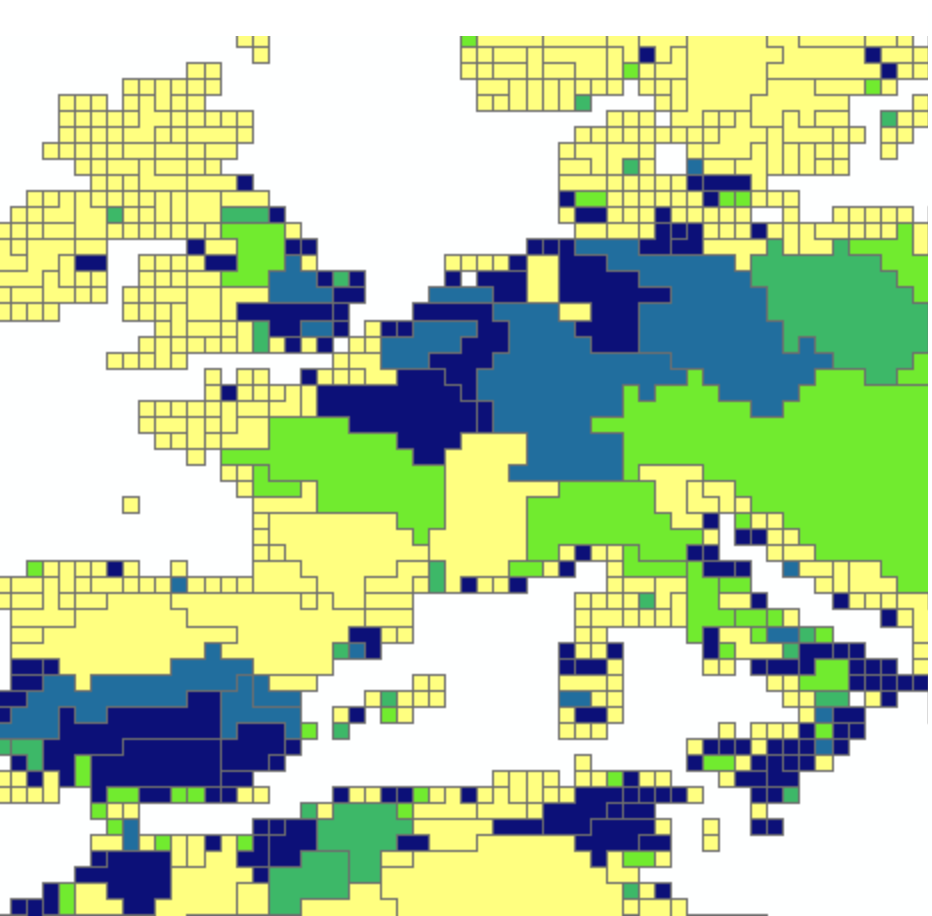
Comparison WATCH results

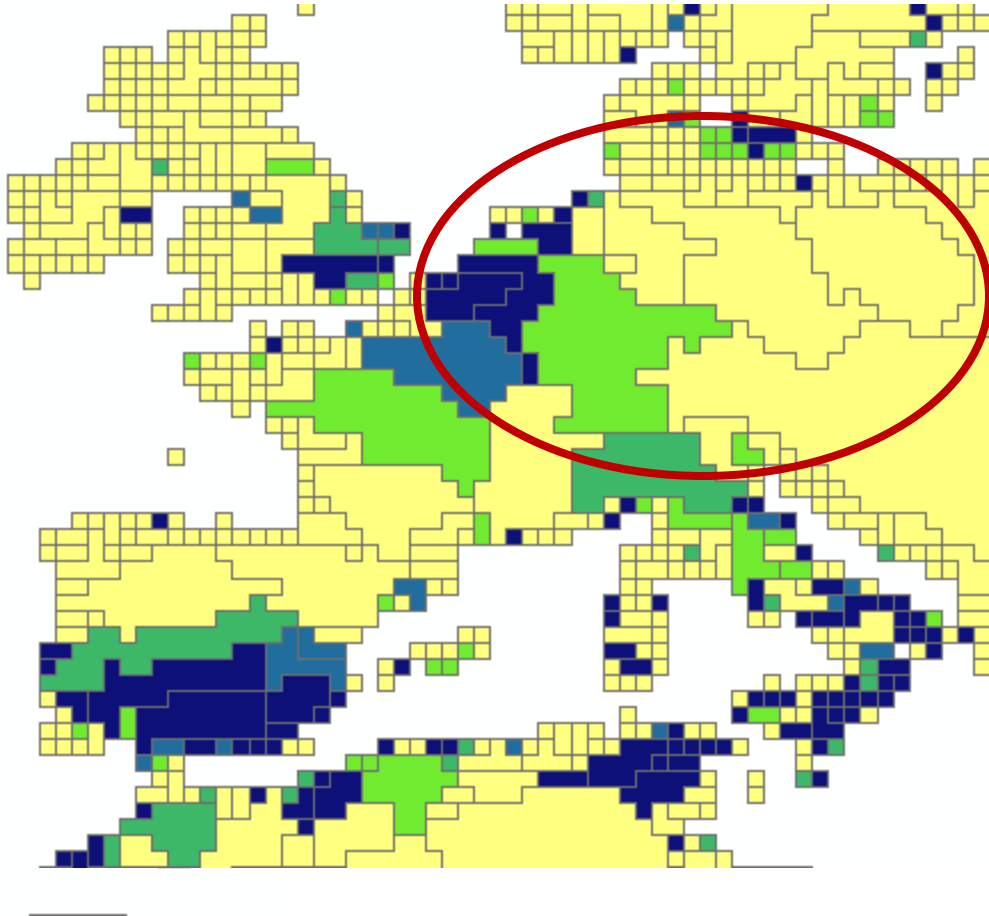
- Hydrological data update
  - Ref year 2010
  - Comparison of different models
- Consumption to availability (CTA)
- Groundwater / surface water distinction

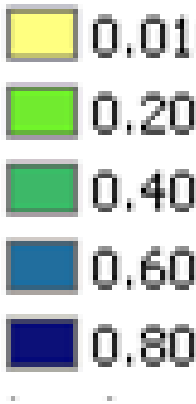
Comparison WTA/CTA

- WSI_WTA

WSI_CTA

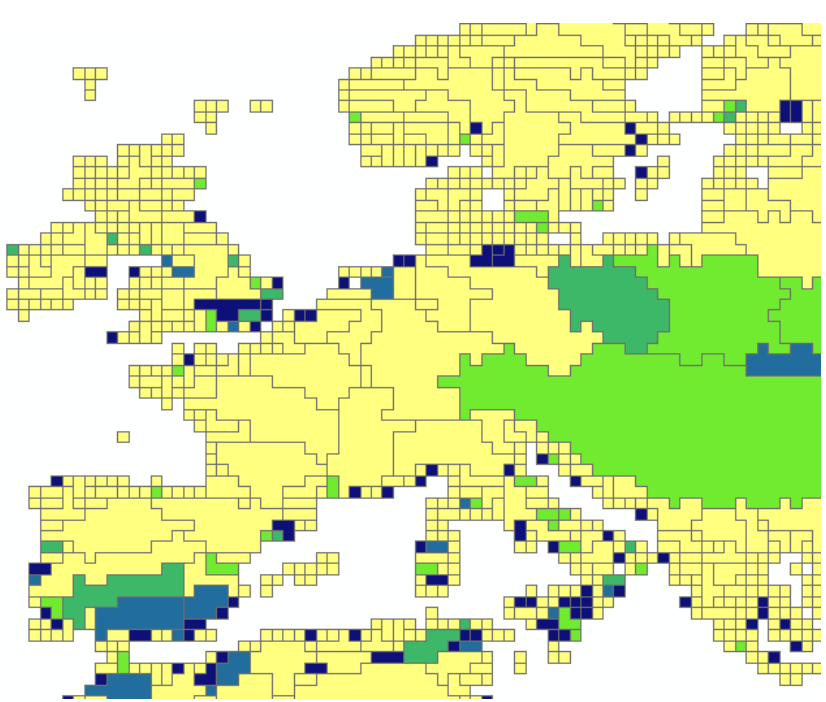




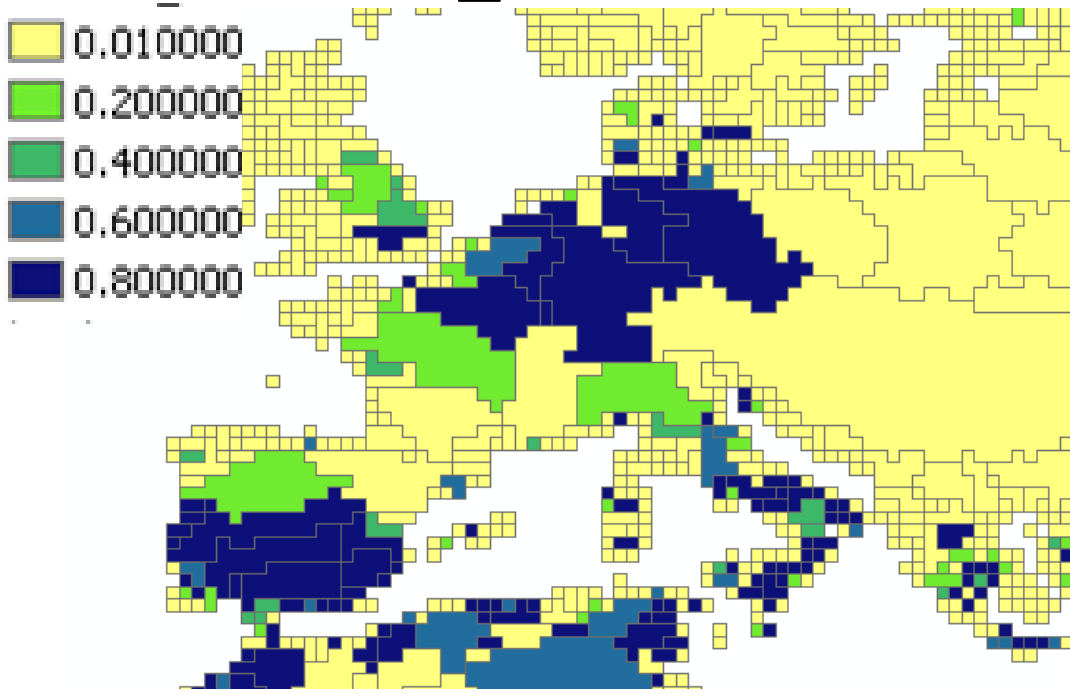


Ground / surface water (WATCH data)

WSI_SW



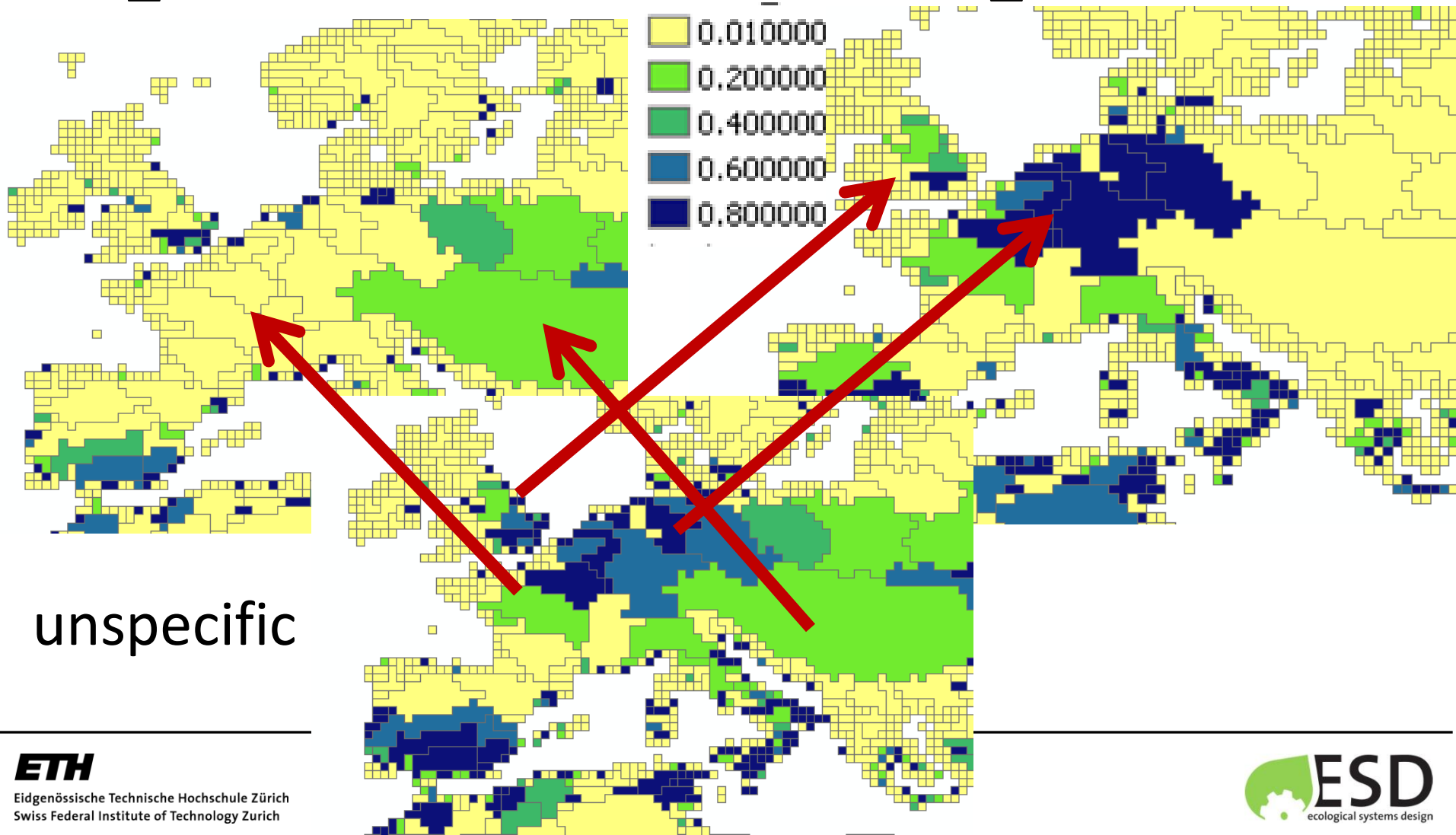
WSI_GW



Ground / surface water (WATCH data)

WSI_SW

WSI_GW

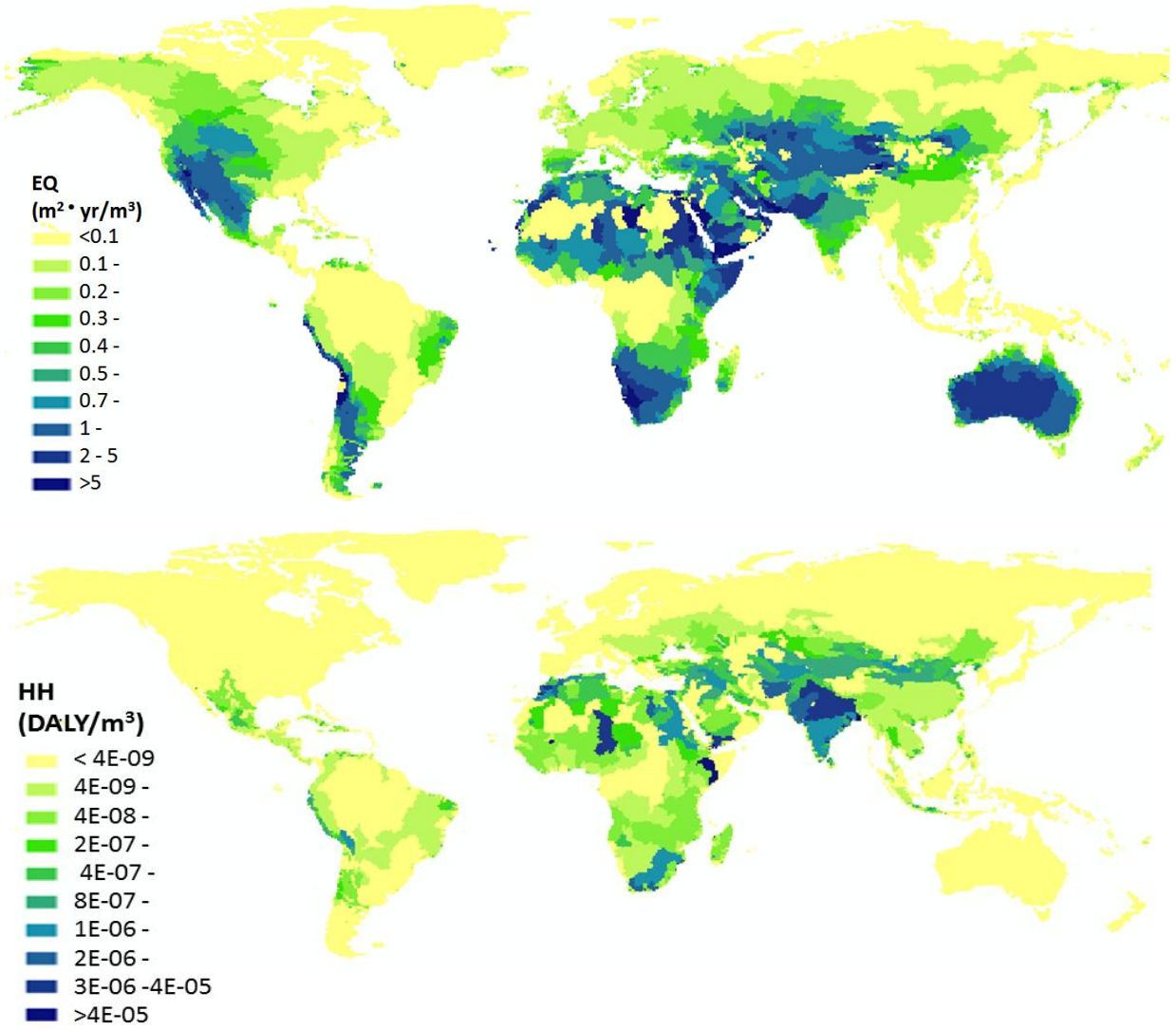


unspecific

Endpoint based WSI

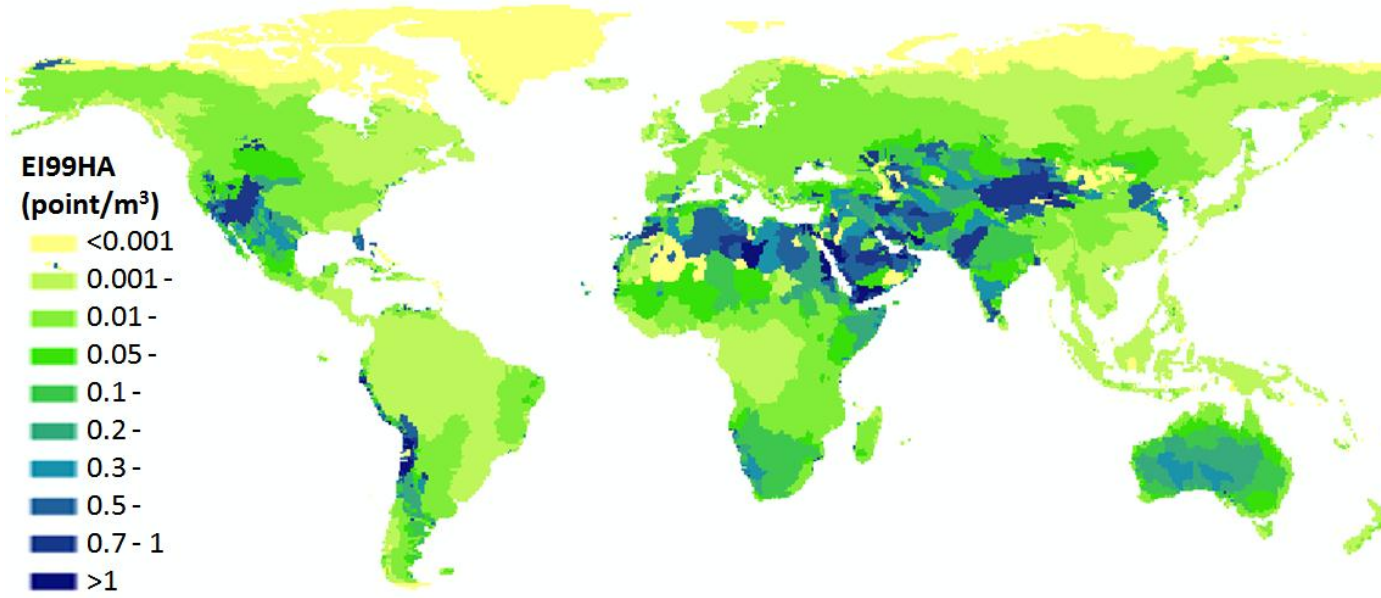
Ecosystem Quality

Human health



Endpoint based WSI

EI99 single score



Different indicator scale differently!

Conclusions

- **Hydrological models** need to be improved and better integrated
- **Monthly** resolution is relevant for **agriculture**
- **Consumption** based WSI adds information
- **Surface / groundwater** use needs to be better distinguished
- **Quality aspects** can improve indicator (data limitation)

THANKS FOR YOUR ATTENTION!

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Monthly characterization published :
http://www.ifu.ethz.ch/ESD/downloads/

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