

# SUSTAINABLE PHOSPHORUS MANAGEMENT IN FLORIDA



DEAN R. DOBBERFUHL, PH.D.

# MINING





# AGRICULTURE



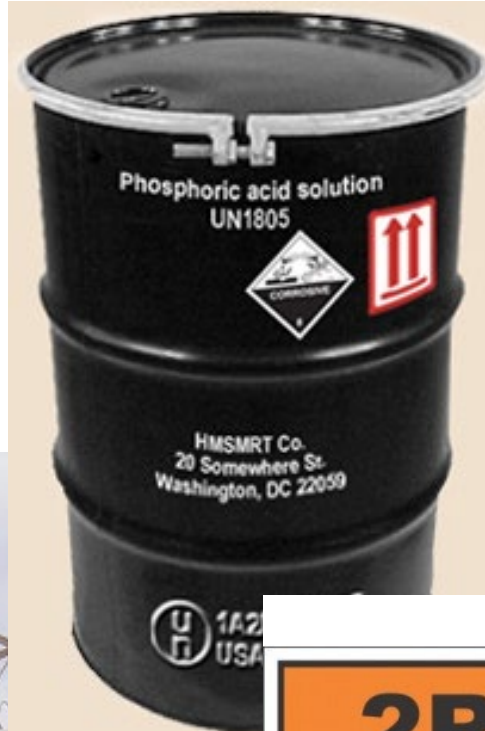


# LANDSCAPING





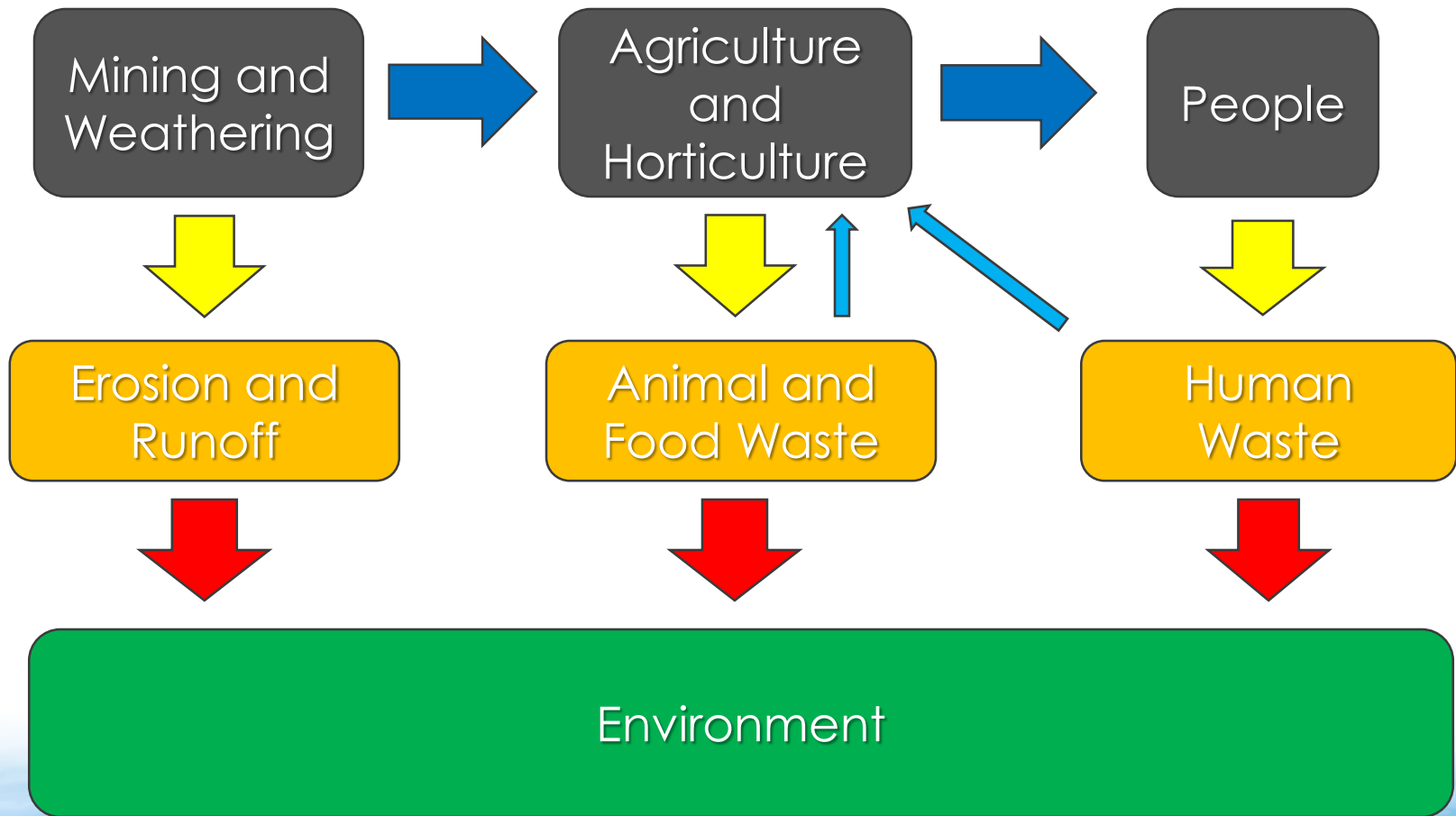
# INDUSTRY



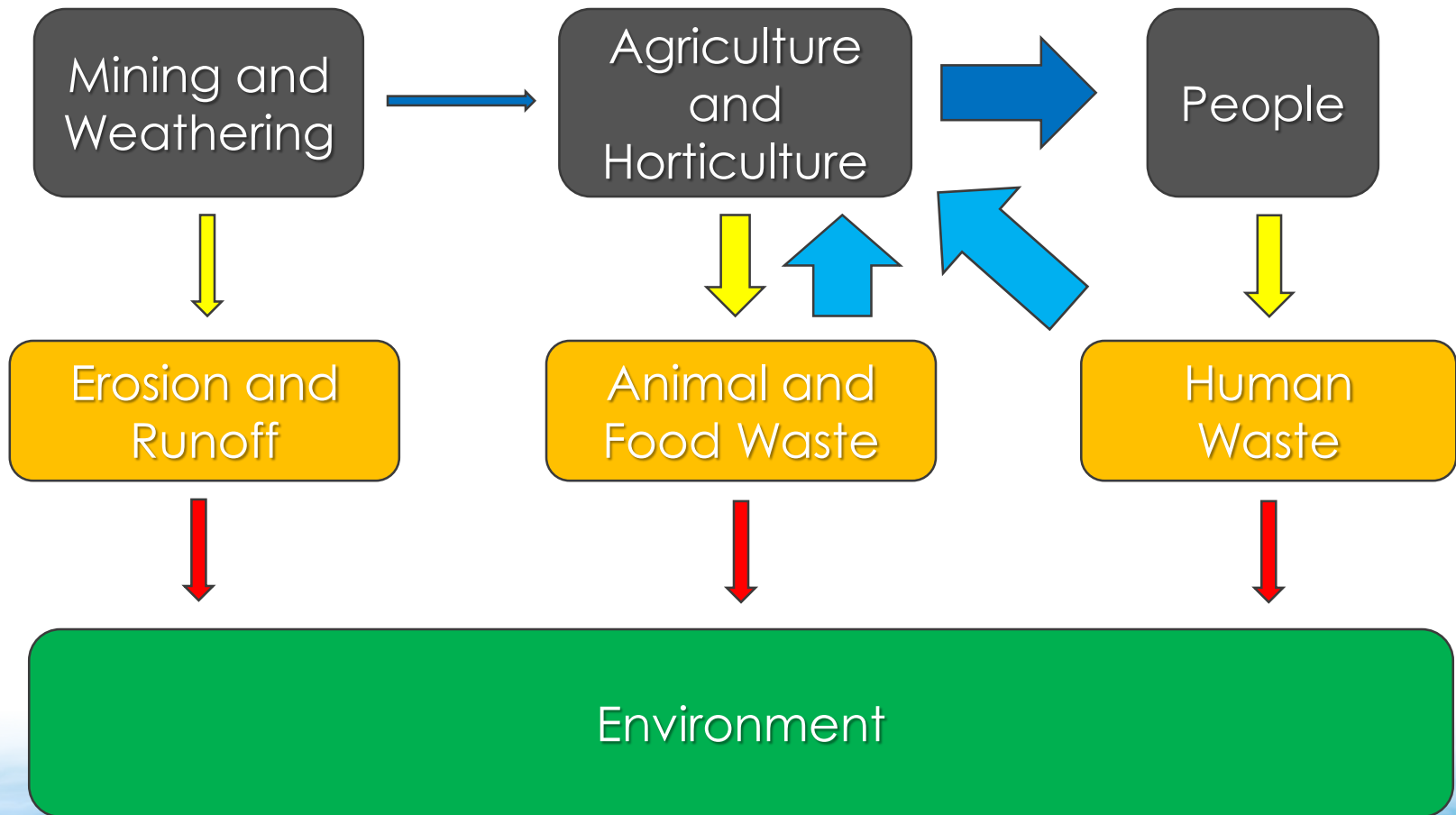
<b>2R</b>	
<b>1805</b>	
<b>(083) 333 3333</b> <b>011 111 1111</b>	

Results found for UN1805  
Material: Phosphoric acid solution  
Hazard Class: 8  
UN Number: UN1805  
Packing Group: III  
Label Codes: 8  
Special Provisions: A7, IB3, N34, T4, TP1  
Exceptions: 154  
Non bulk: 203  
Bulk: 241  
Passenger aircraft rail: 5 L  
Cargo aircraft only: 60 L  
Location: A  
sku: Hz011

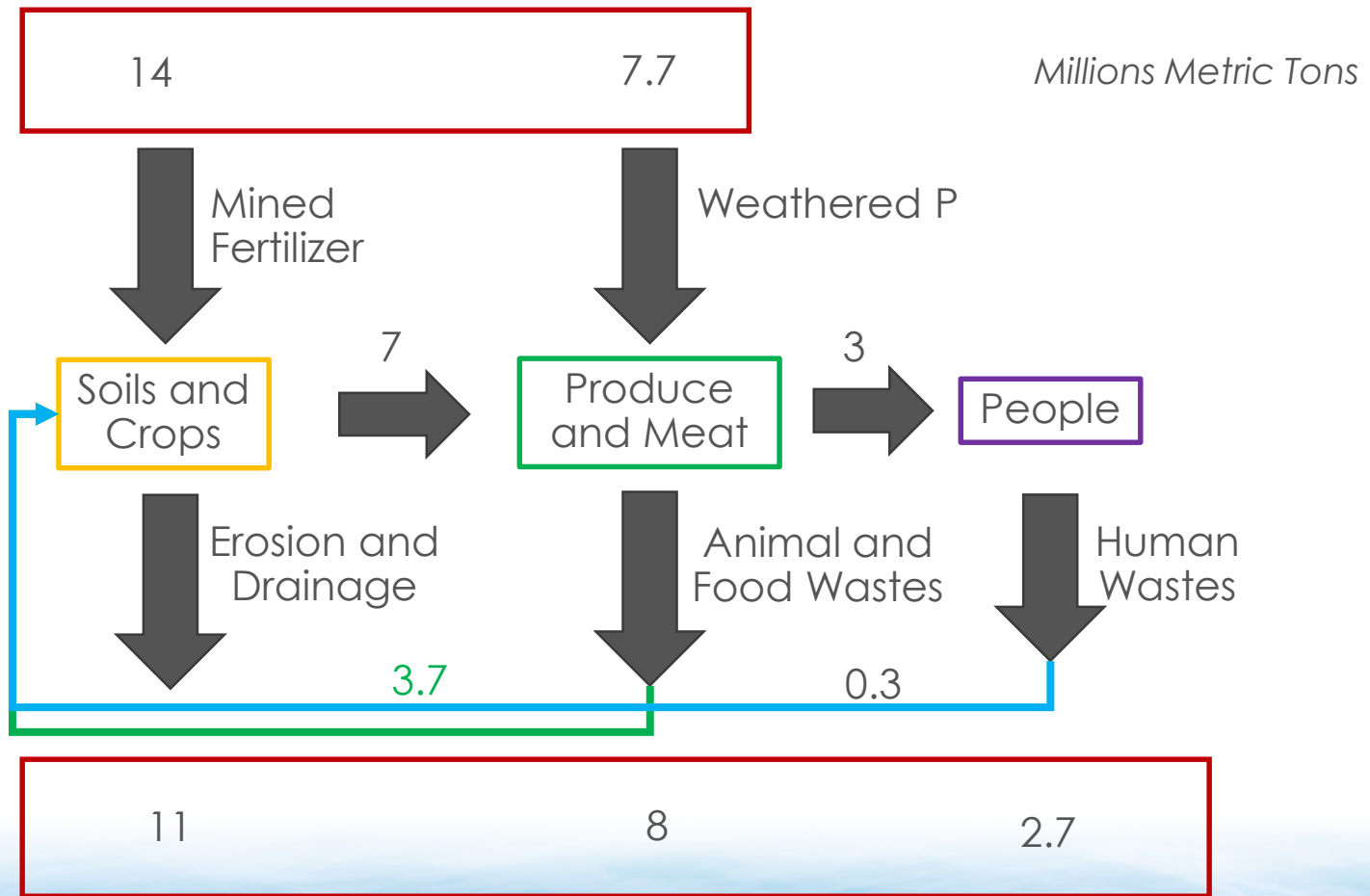
# CURRENT P SUPPLY CHAIN



# “IMPROVED” P SUPPLY CHAIN

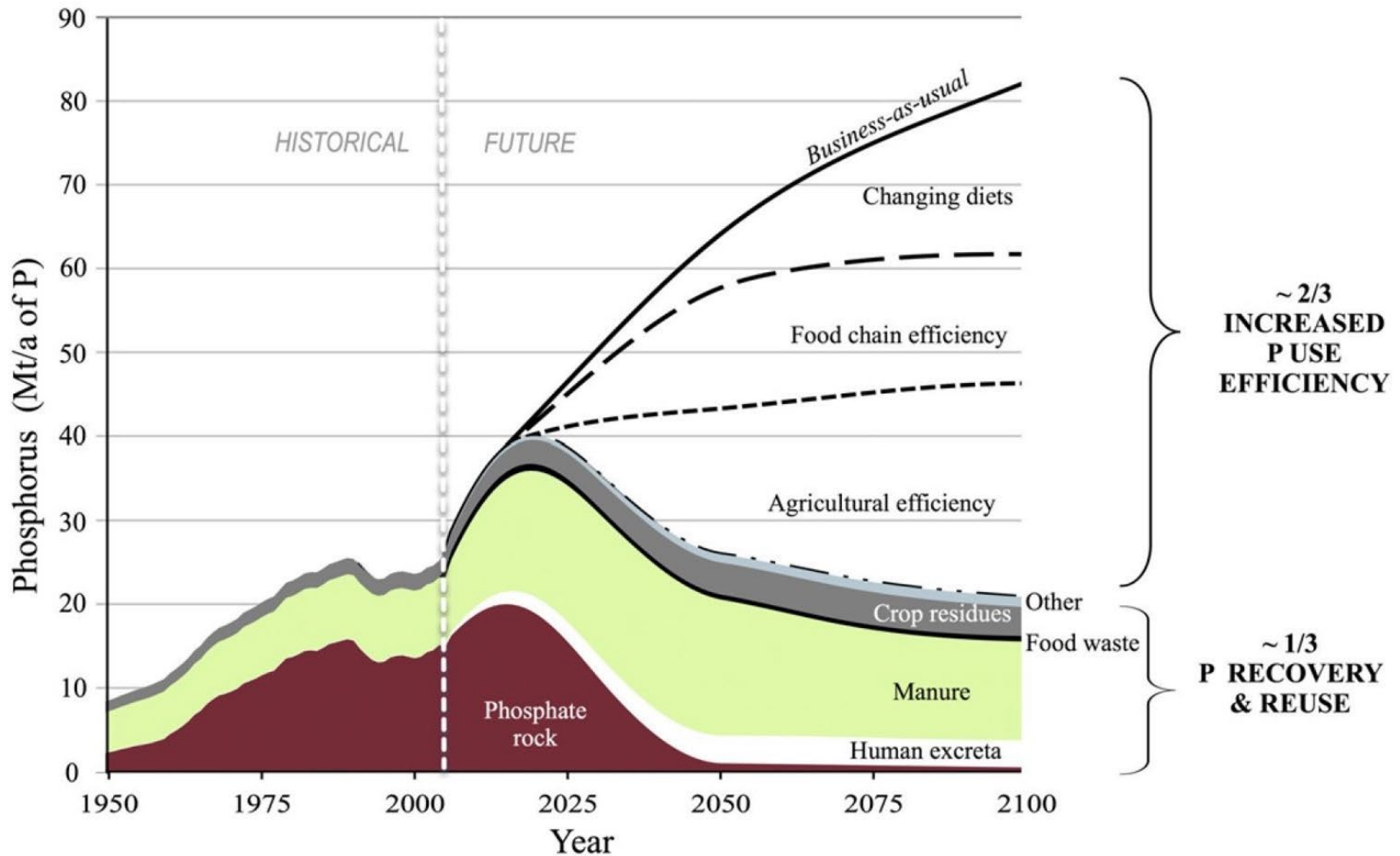


# GLOBAL P SUPPLY CHAIN



Based on illustrations by Elser and Rittmann from published work by Dana Cordell and co-workers.





*A backcasting analysis of global P use to achieve a sustainable target that eliminates reliance on mined phosphate rock by the year 2050. From Cordell et al. (2009).*

# FLORIDA EXAMPLES: REUSE





# WASTEWATER P REMOVAL

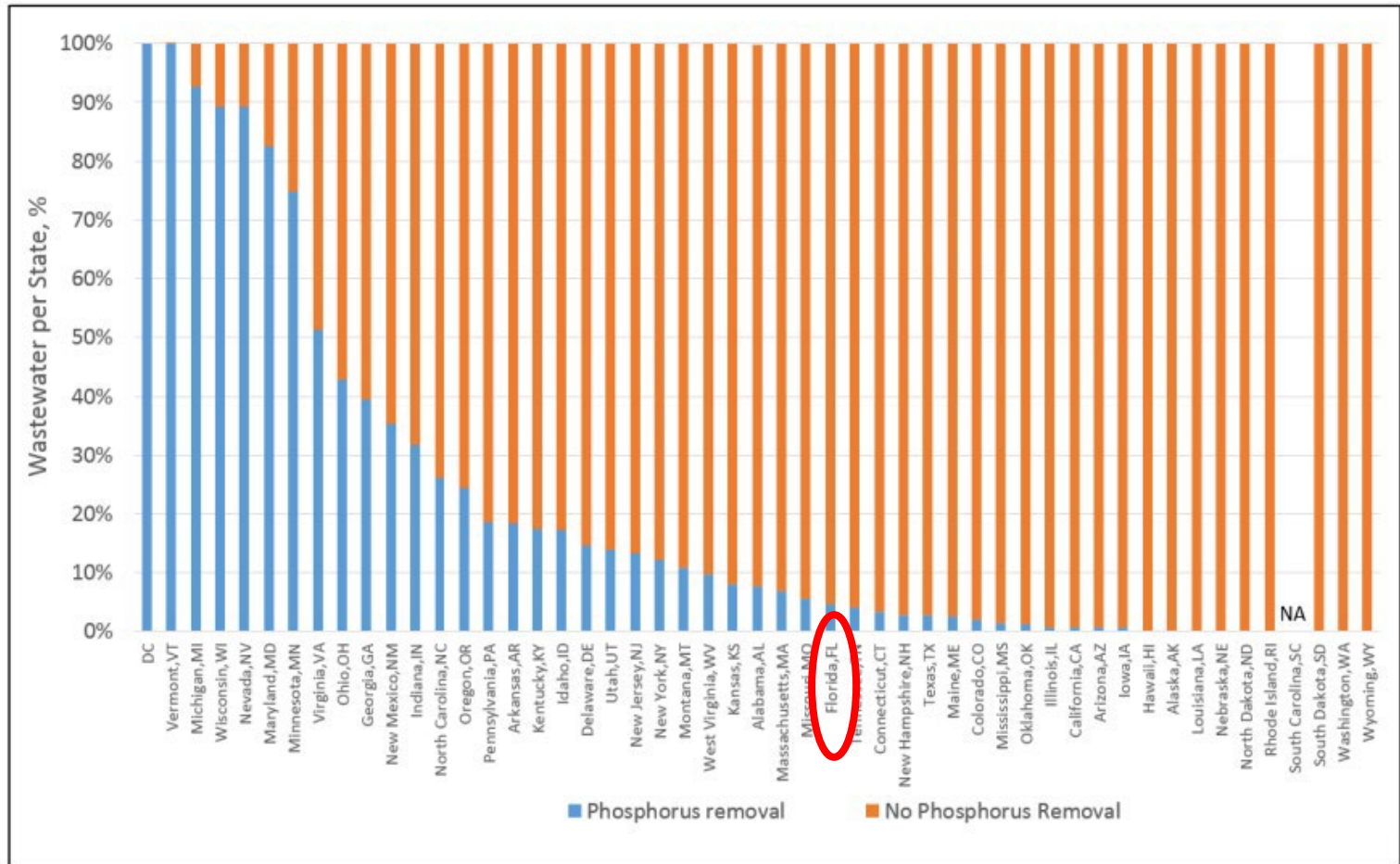
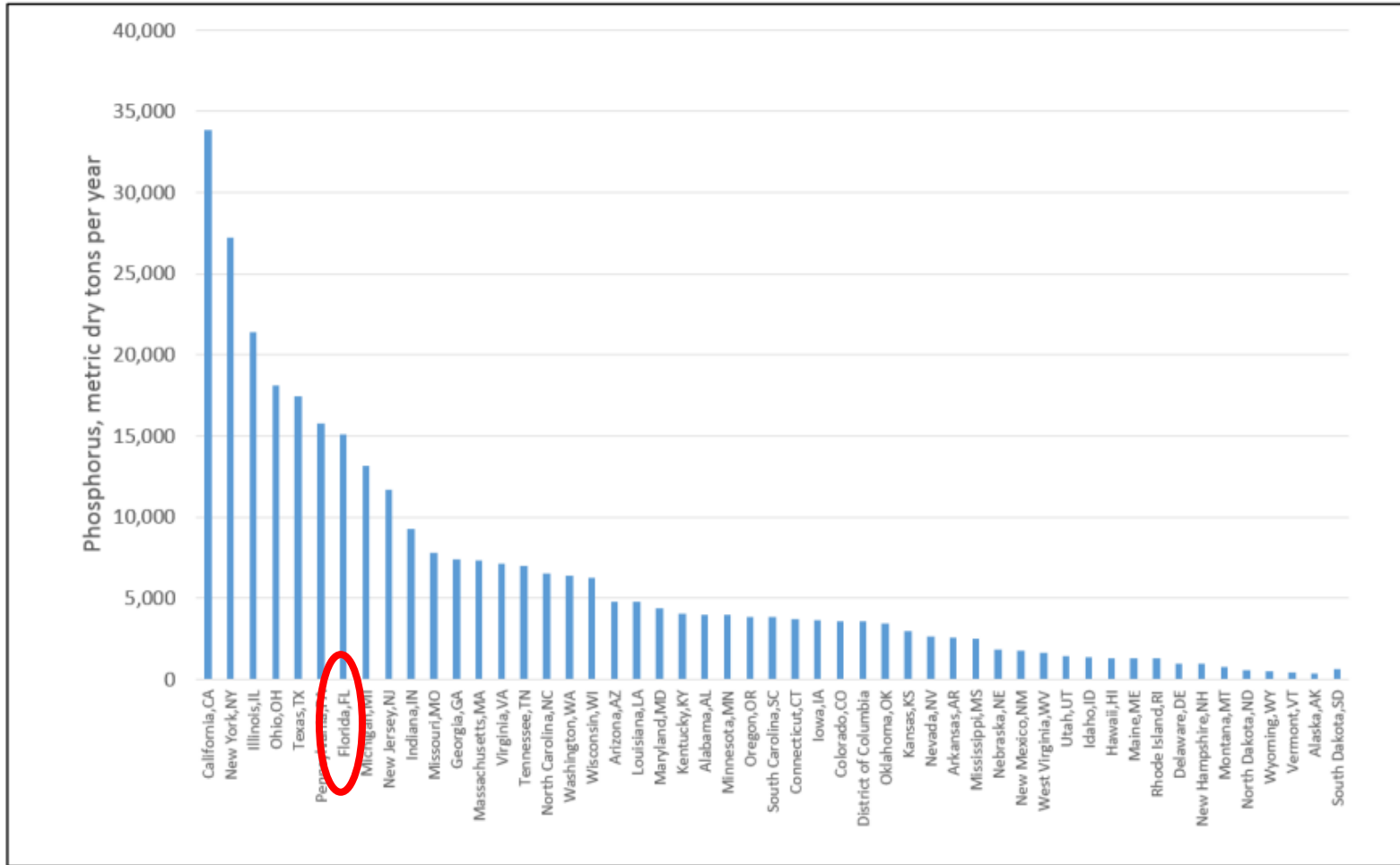


Figure 19 Percent Wastewater by State Treated with and without Phosphorus Removal

Patrick Dube, Phosphorus Forum 2019

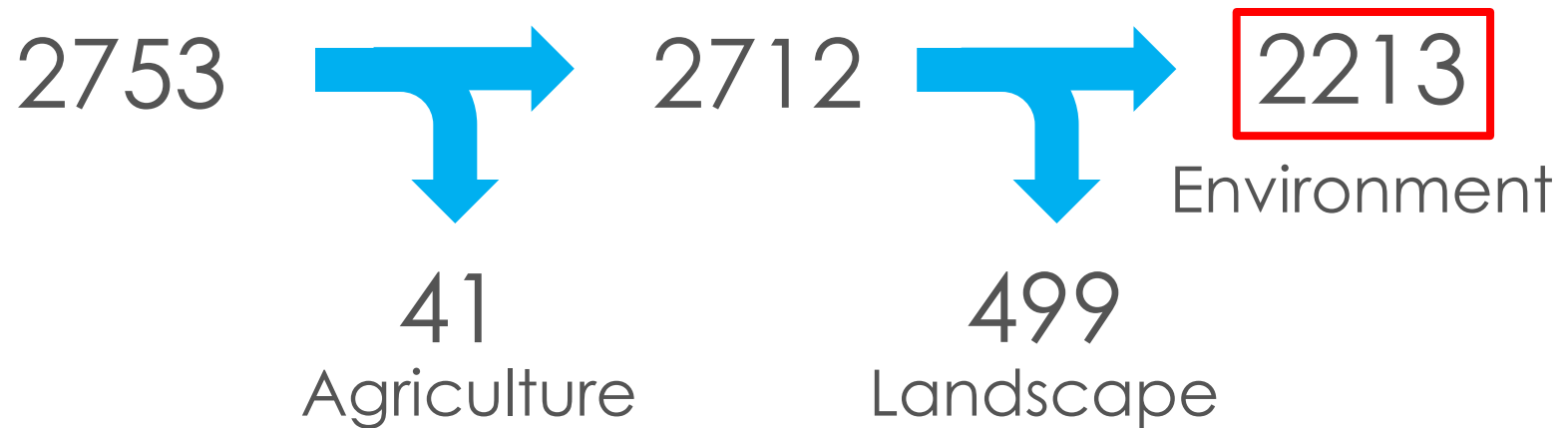
# WASTEWATER P LOAD



Patrick Dube , Phosphorus Forum 2019

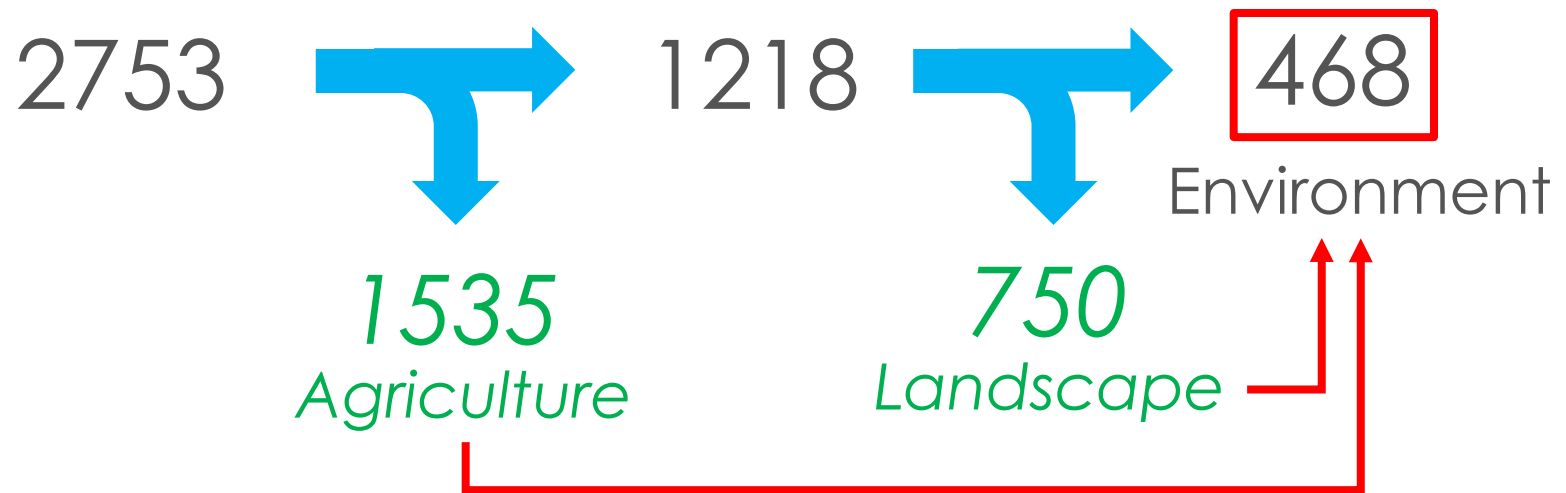


# SUPPLY CHAIN LEAKAGE RECLAIMED WATER



MT P, SJRWMD 2018

# SUPPLY CHAIN LEAKAGE RECLAIMED WATER ENHANCED



MT P, SJRWMD 2018



# FLORIDA EXAMPLE: BIOSOLIDS



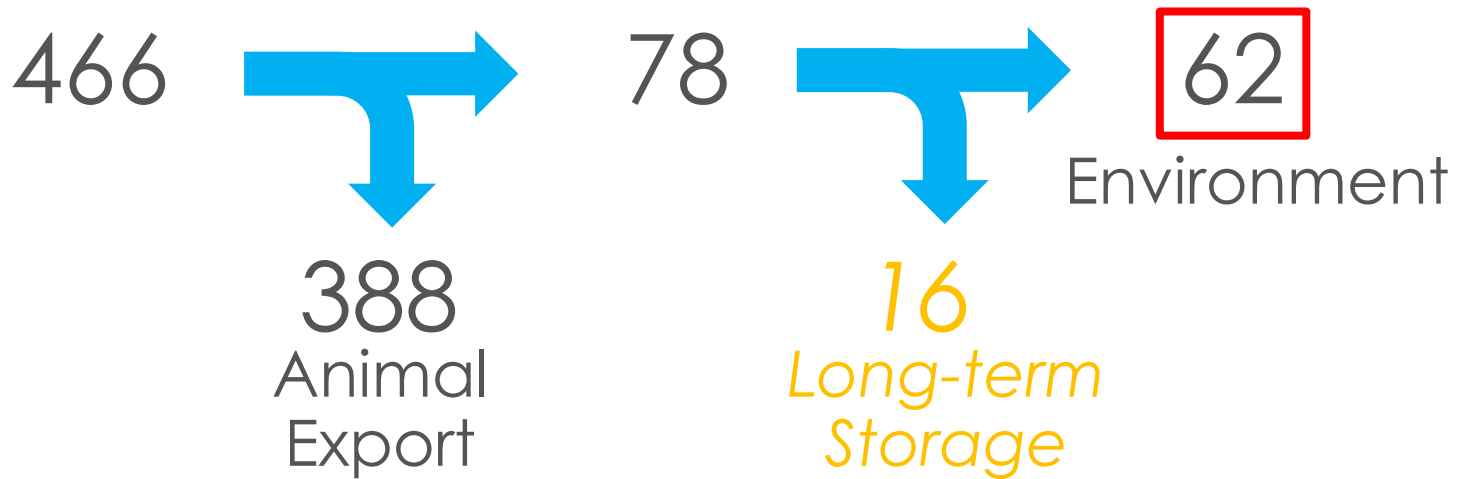
# SUPPLY CHAIN LEAKAGE BIOSOLIDS



MT P, SJRWMD 2018

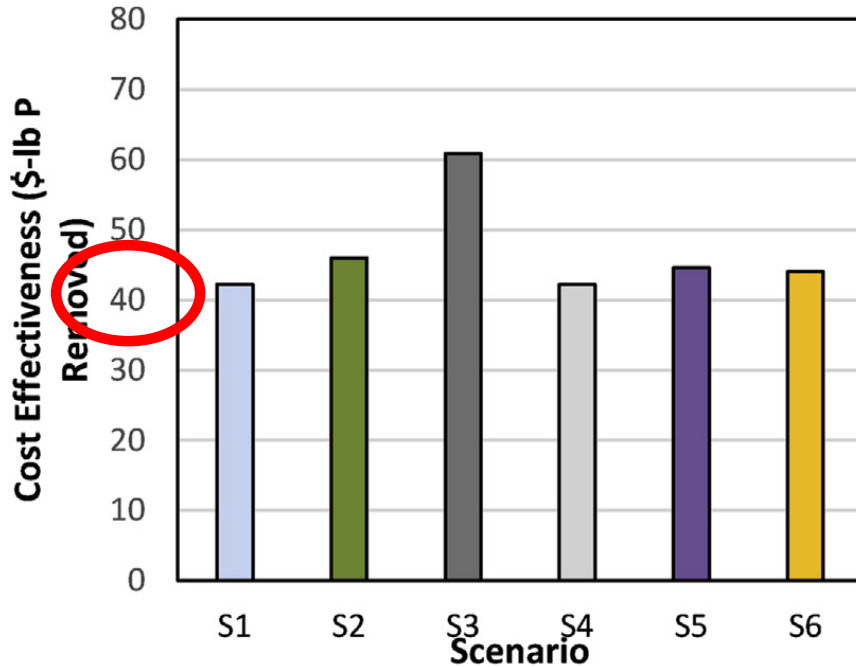


# SUPPLY CHAIN LEAKAGE BIOSOLIDS ENHANCED

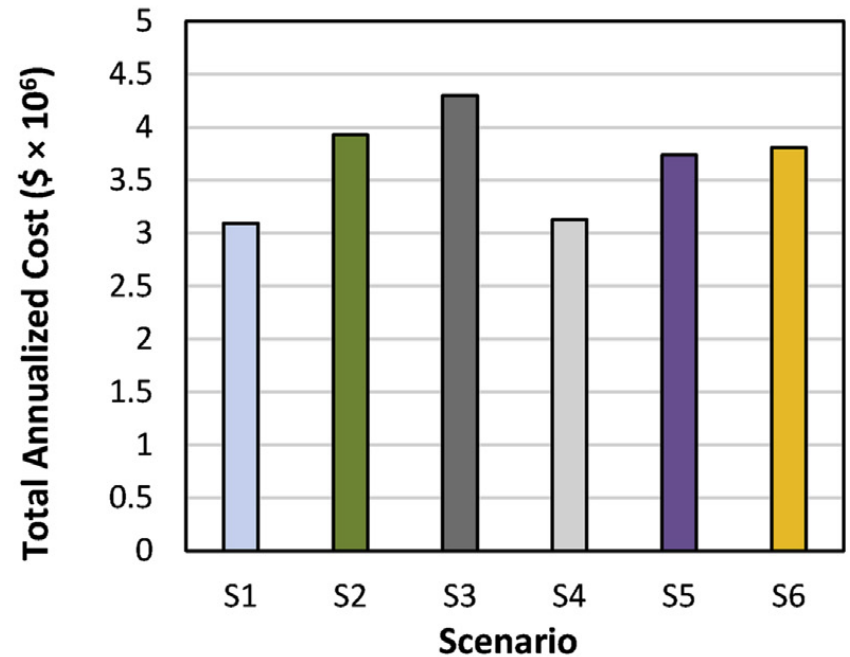


MT P, SJRWMD 2018

# SHOW ME THE MONEY



(a)



(b)

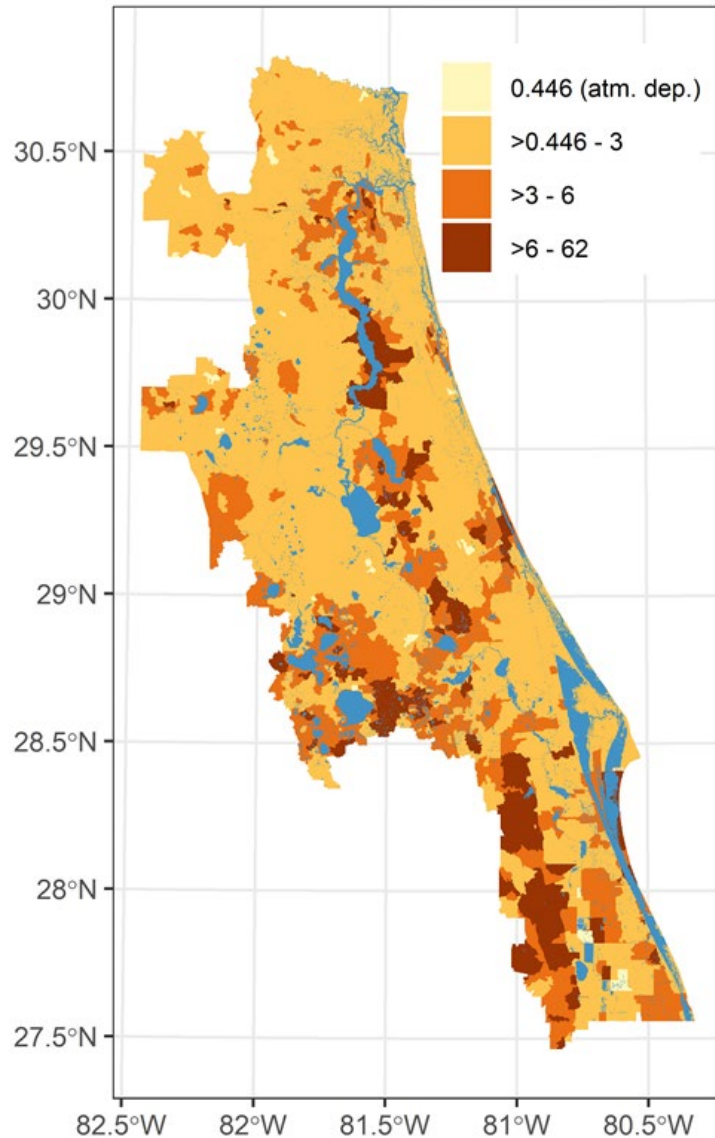
Fig. 4. (a) Cost effectiveness (\$/lb P removed), and (b) Total annualized cost for different treatment scenarios.

Bashar et al. 2018



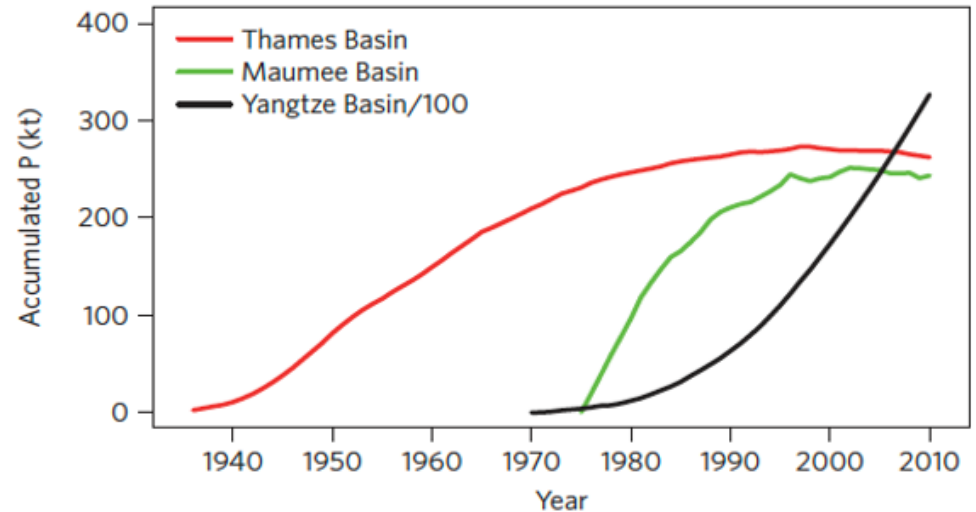
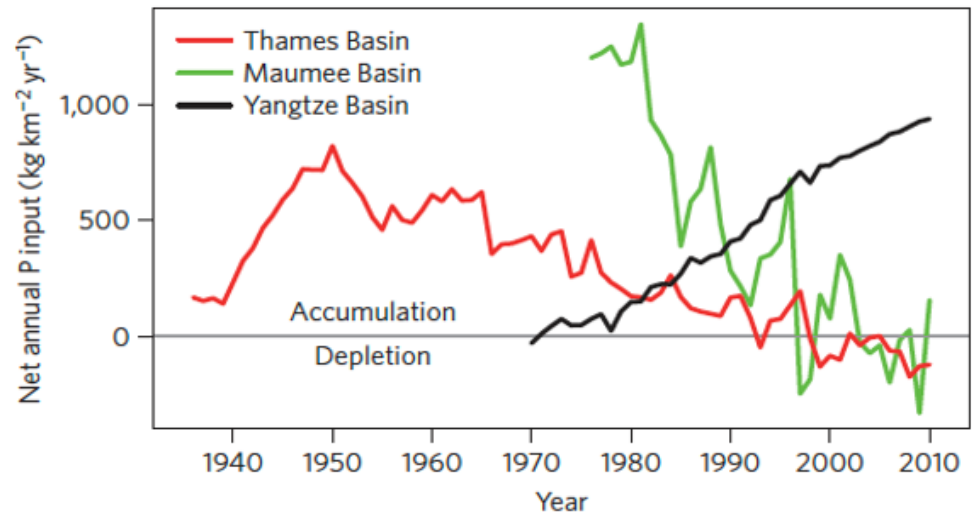
# PHOSPHORUS HEAT MAP

Selected sources total application-to-land  
Phosphorus (lb/ac) per subbasin



- Atmospheric Deposition
- Fertilizer
- OSDS
- Reclaimed/RIBS
- Biosolids

# WATERSHED STORAGE AND LEGACY LOAD



**Figure 3 | Net annual P input and accumulation curves for landscape P pools (soils plus aquatic systems) of three river basins (Maumee River, USA; Thames River, UK; Yangtze River, China). Accumulated P is the cumulative sum of net annual P input over time.**

Powers, S.M., T.W. Bruulsema, T.P. Burt, N. Chan, J.J. Elser, et al. 2016. *Nature Geoscience* **9**: 353–356.