ISRIC's role in a digitizing world facing scarcity of natural resources

ISRIC World Soil Information

Prem Bindraban

Director ISRIC

Advancing the Science and Technology of Soil Information in Asia —

Launch of the Global Soil Partnership's Asia Soil Science Network and GlobalSoilMap.net East Asia Node

8-11 February, 2012, Nanjing, China

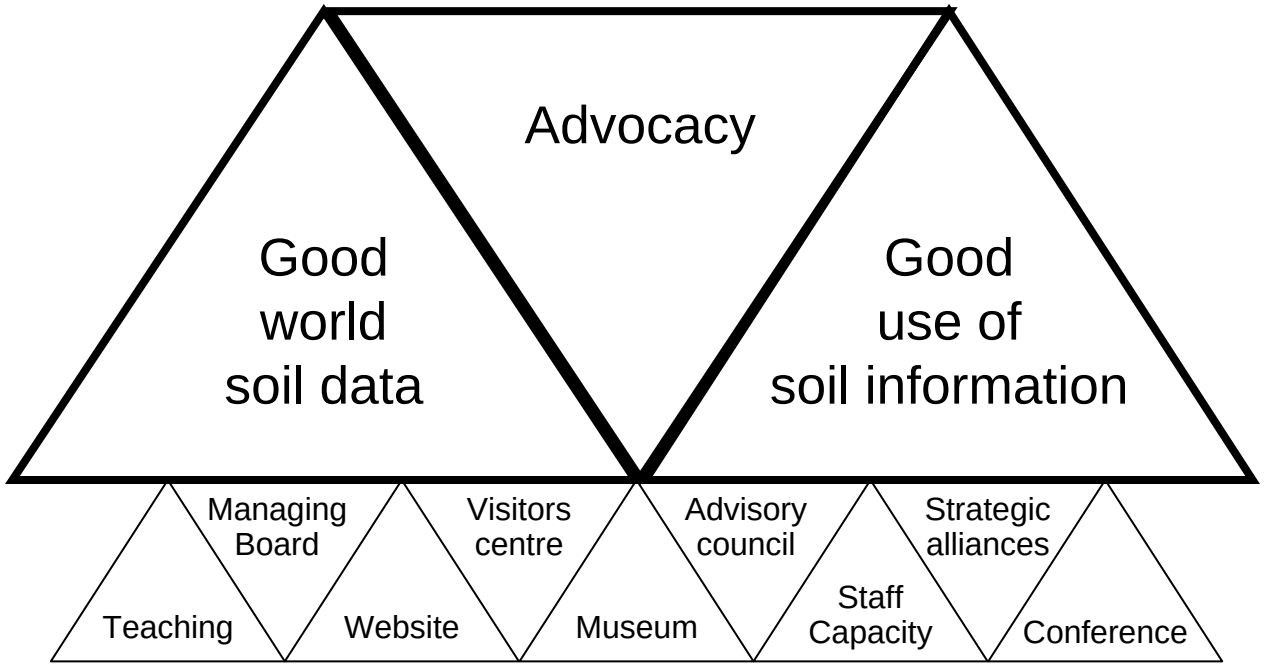
ISRIC – The foundation

- Independent foundation
  - UNESCO/Min. Education mandate 1964
- ICSU World Data Centre for Soils
- Collaboration/MoU
  - FAO, JRC, Wageningen UR, …
- Track record
  - FAO, WB, IFAD, UNEP, CGIAR, CDE, PBL, WUR, national institute, Universities
  - Soil maps, Reference collection, Library, Museum, GLASOD, DSM, Degradation, Soil Water, Soil Carbon, Phosphorus

Mandate

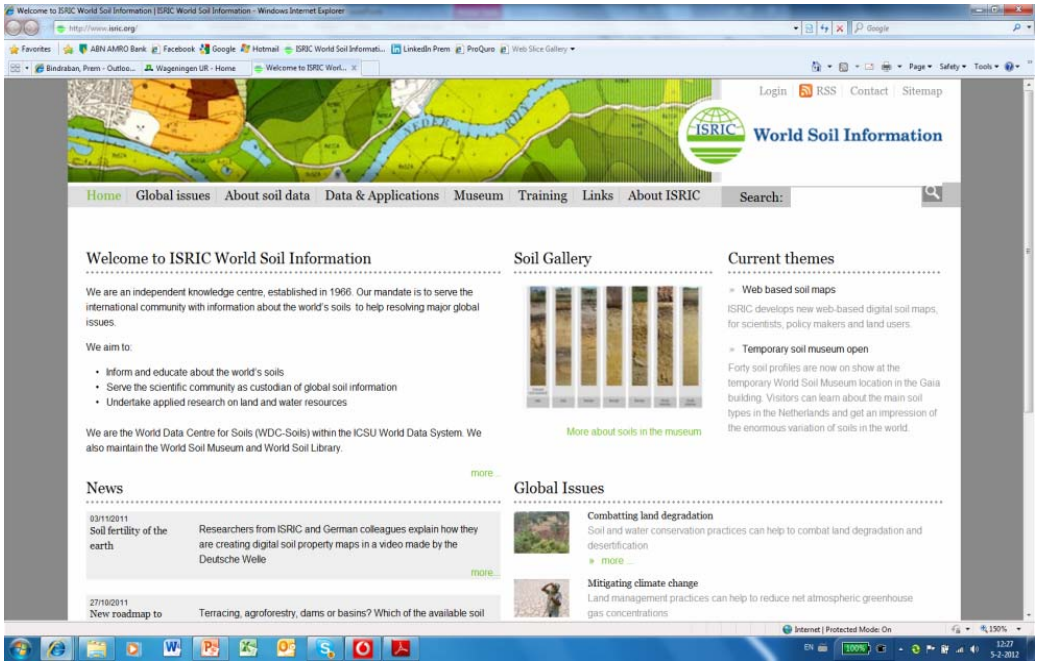
ISRIC – World Soil Information has a mandate to serve the international community as custondian of global soil information and to increase awareness and understanding of soils in major global issues.

Priority areas



ISRIC – advancements - I

ISRIC World Wide Web site

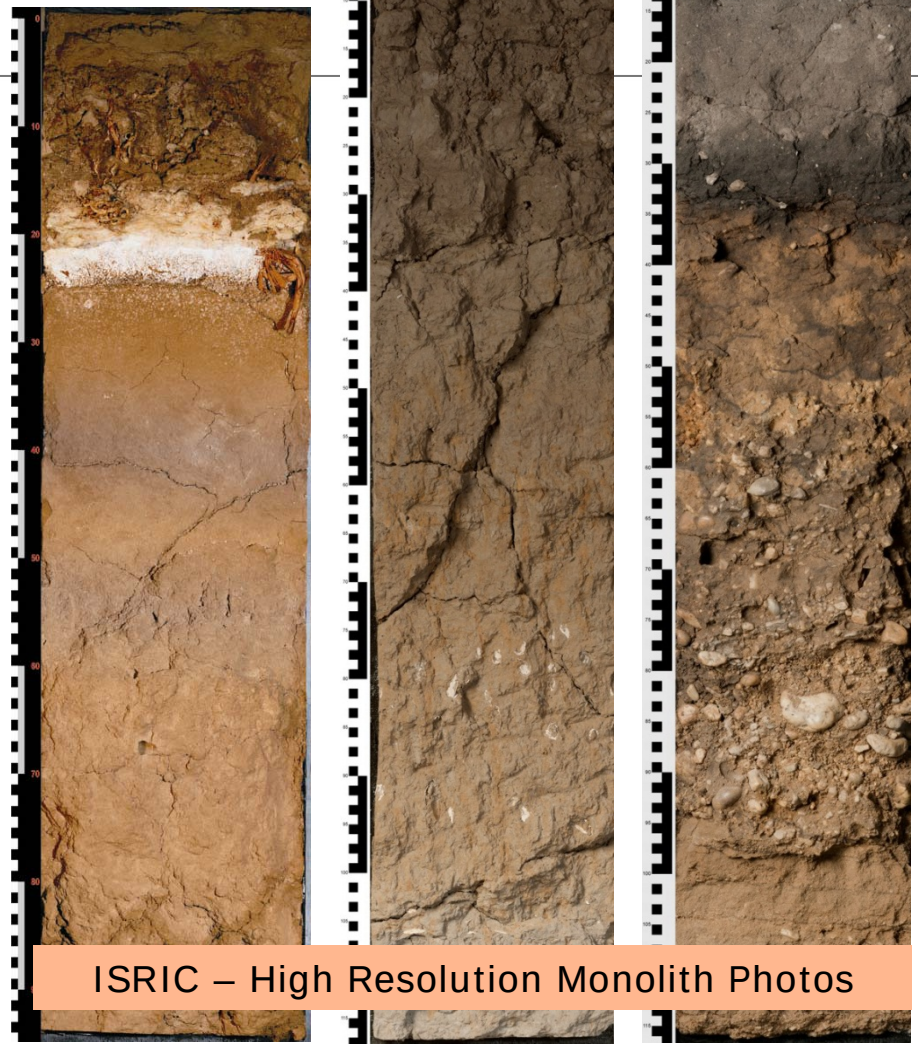


ISRIC Temporary museum

ISRIC World Soil Information

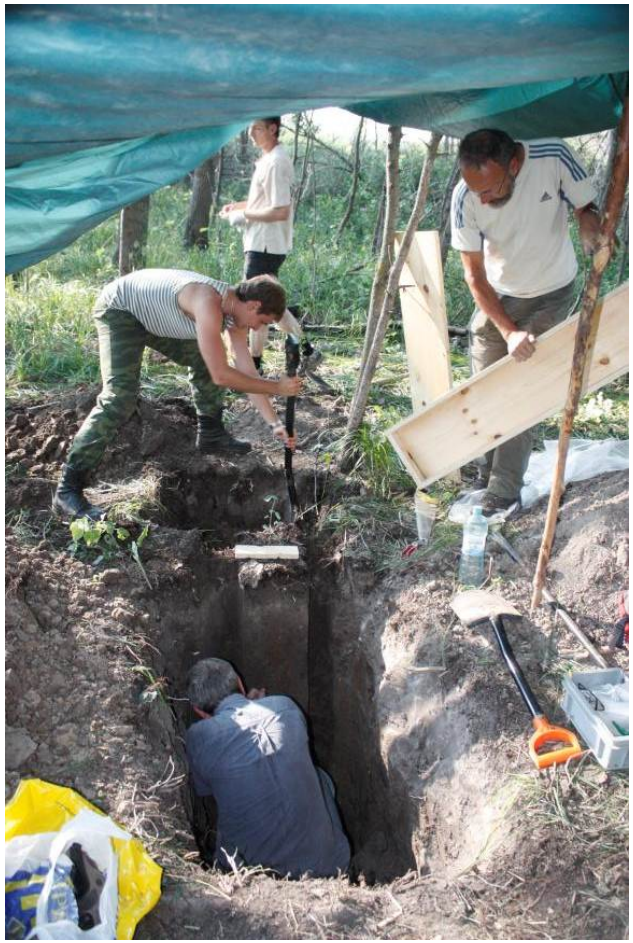
ISRIC – advancements - II

ISRIC Digitized storage



ISRIC – High Resolution Monolith Photos

ISRIC – advancements - III



ISRIC – Strategic expansion of reference soil samples.

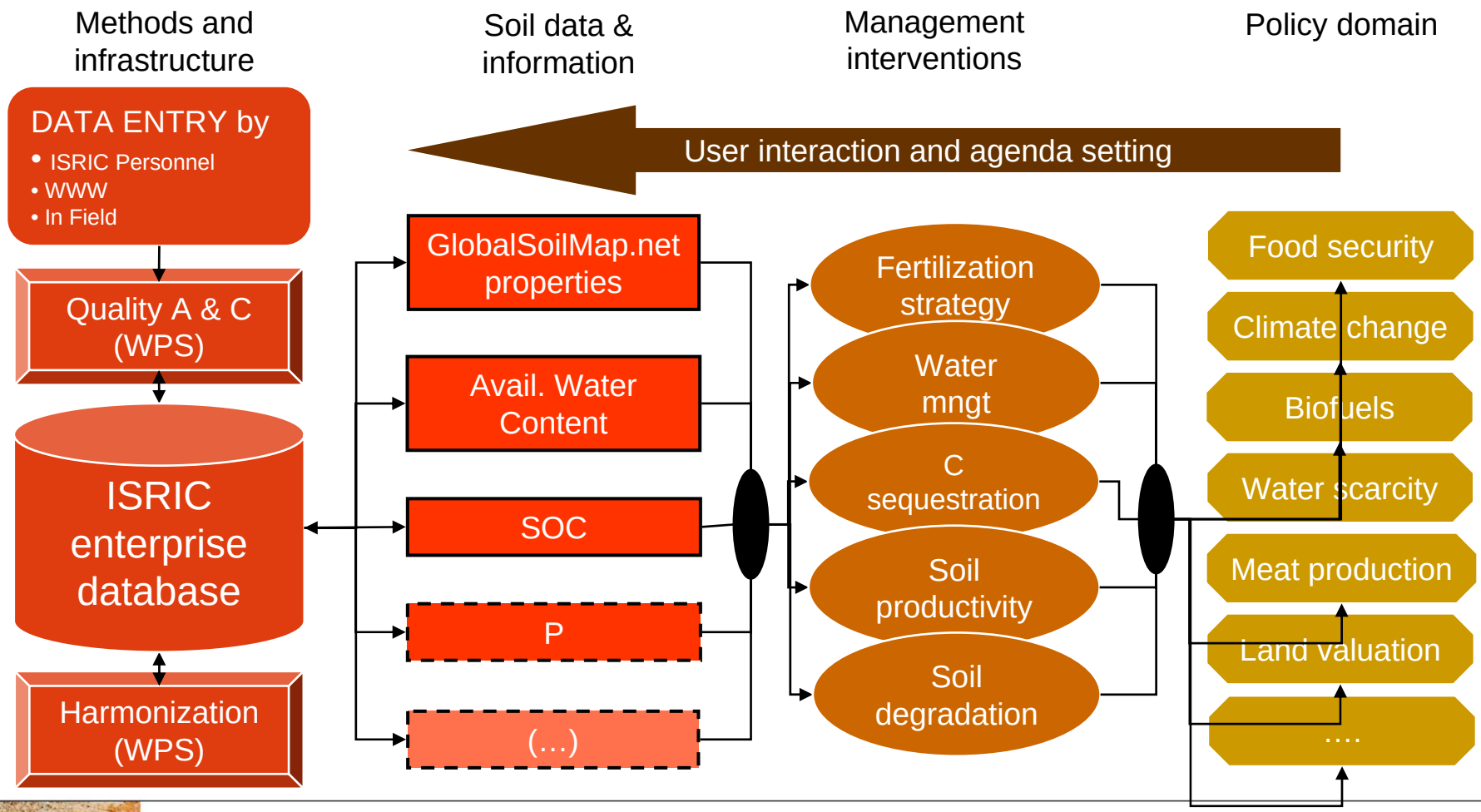
ISRIC – advancements - IV

ISRIC World Soil Education Centre

ISRIC Virtual Museum

ISRIC World Soil Information

Linking ISRIC soil information to policy and farm recommendation



Open Soil Profiles

Soil variables
Soil site info
Soil analytical data
Descriptive properties

Soil covariates (worldgrids)

Global

5.6 km repository

Continental scale

Country/state-level

1 km repository

100 / 250 m repository

Area-class maps

Scale:
Global, Continental, regional
Soil property
Taxonomical / analytical/site data

Tom Hengl

(GSIF Servers) cyber infrastructure

GSIF Packages

- Map import module
- Data entry module
- Harmonization module
- Spline fitting
- Spatial analysis module
- plotKML
- Data conversion to R
- Data visualization
- Data export

Webmapping API

- Real-time spatial prediction (Google Maps)
- Global SoilMap .net functionality for web-applications
- Geo-serving and geoprocessing capability

Bob McMillan,

Hannes Reuter,

Gerard Heuvelink,

Johan Leenaars,

Piet Tempel,

Niels Batjes,

Etc.

Derived soil property maps

Global coverage

- Six+four key soil parameters (organic carbon , pH, clay, silt, sand, coarse fragments)
- at six standard depths (0-5, 5-15, 15-30, 30-60, 60-100, 100-200 cm)
- and with included upper and lower 95% probability ranges

100 m (250 m, 1 km and 5.6 km)

Derived area-class maps

- Qualitative + quantitative soil properties
- Defined depth ranges (FAO: 0-30 and 30-100;SOTWIS :0-20,20-40,40-60,60-80,80-100)
- Documented uncertainties

1 : 5M, 1 : 1M, 1 : 0.5M, 1 : 0.25M

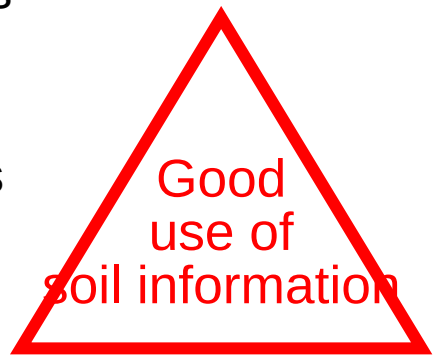
Global development issues

- Climate change
- Food production
- Water scarcity
- Input requirement (N, P, K, H_2O, ...)
- Degradation
- De- / Re-forestation (REDD)
- Bio-energy
- Marginal lands (micro nutrients, toxicity, salinity, acidity, ...)
- ...

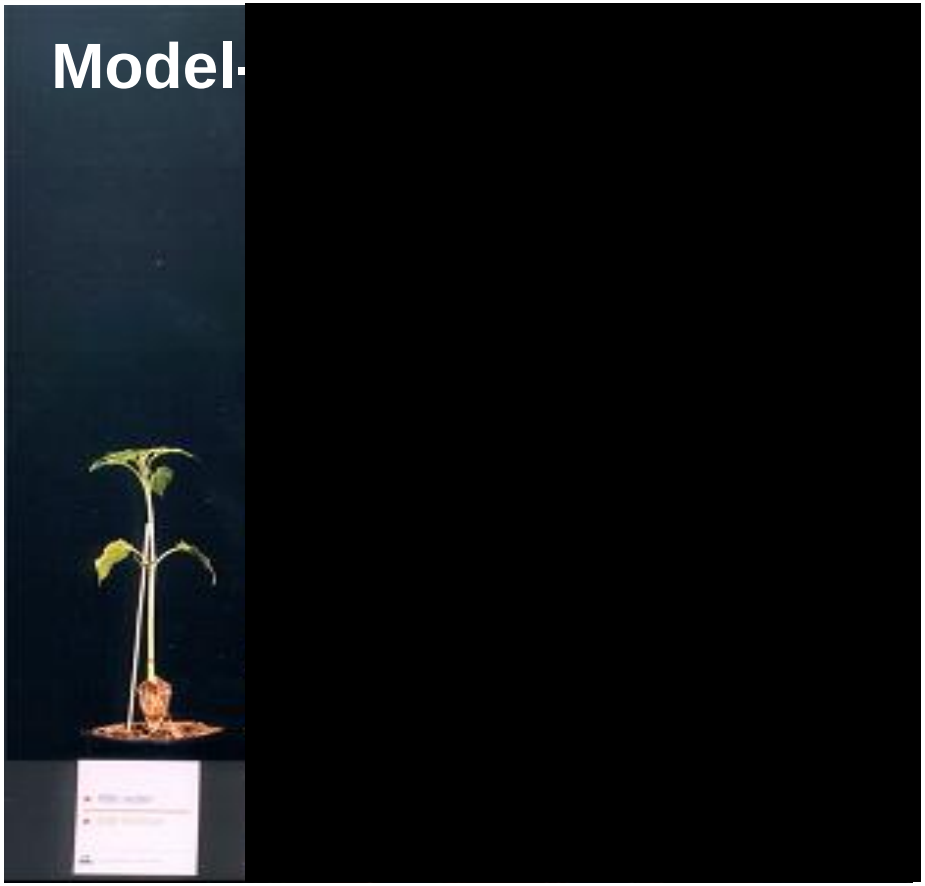
ISRIC – World Soil Information

- New insights essential for making strategic choices to resolve current global developments

- ISRIC has much GOOD DATA BUT
  - Not necessarily fit to address current global issues
    - Soil Carbon, P, micro nutrients, …
  - Incomplete sets and too low resolution
  - Should exploit new techniques and methodologies
- ISRIC to stimulate GOOD USE OF DATA
  - Carbon sequestration, GWC, degradation, fertility
- ISRIC develops internet based geo-reference (soil and terrain) data and service infrastructure



Production ecological principles



- water
- nutrients

+ water
- nutrients

- water
+ nutrients

+ water
+ nutrients

- The best irrigation is fertilization
- Most efficient use of water and fertilizers
- Highest radiation use efficiency at high yields
- Least land for most product
- Lowest input per unit product
- Ecologically most sustainable

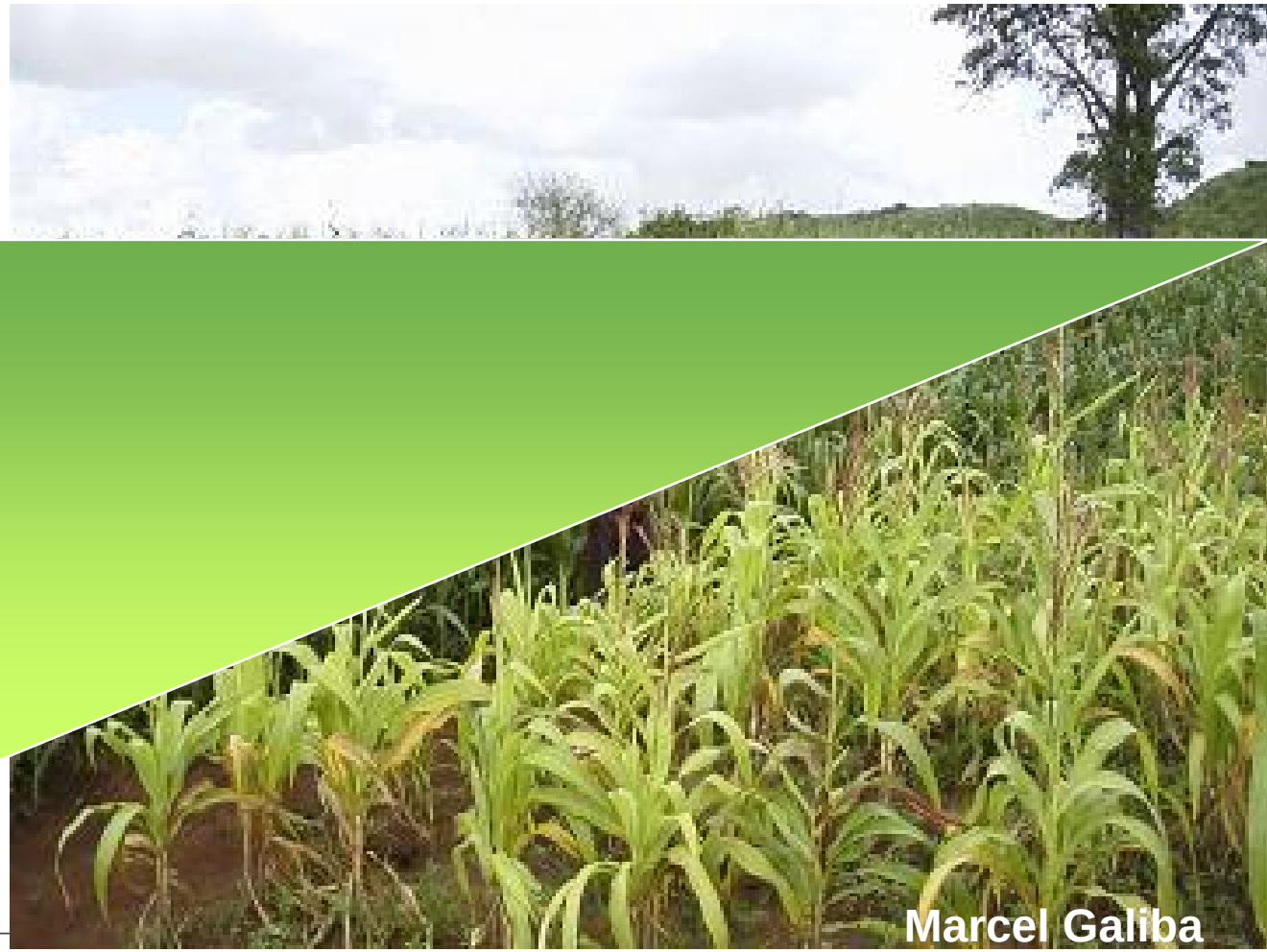
Optimize, not maximize input use

Based on own experiments Prem Bindraban

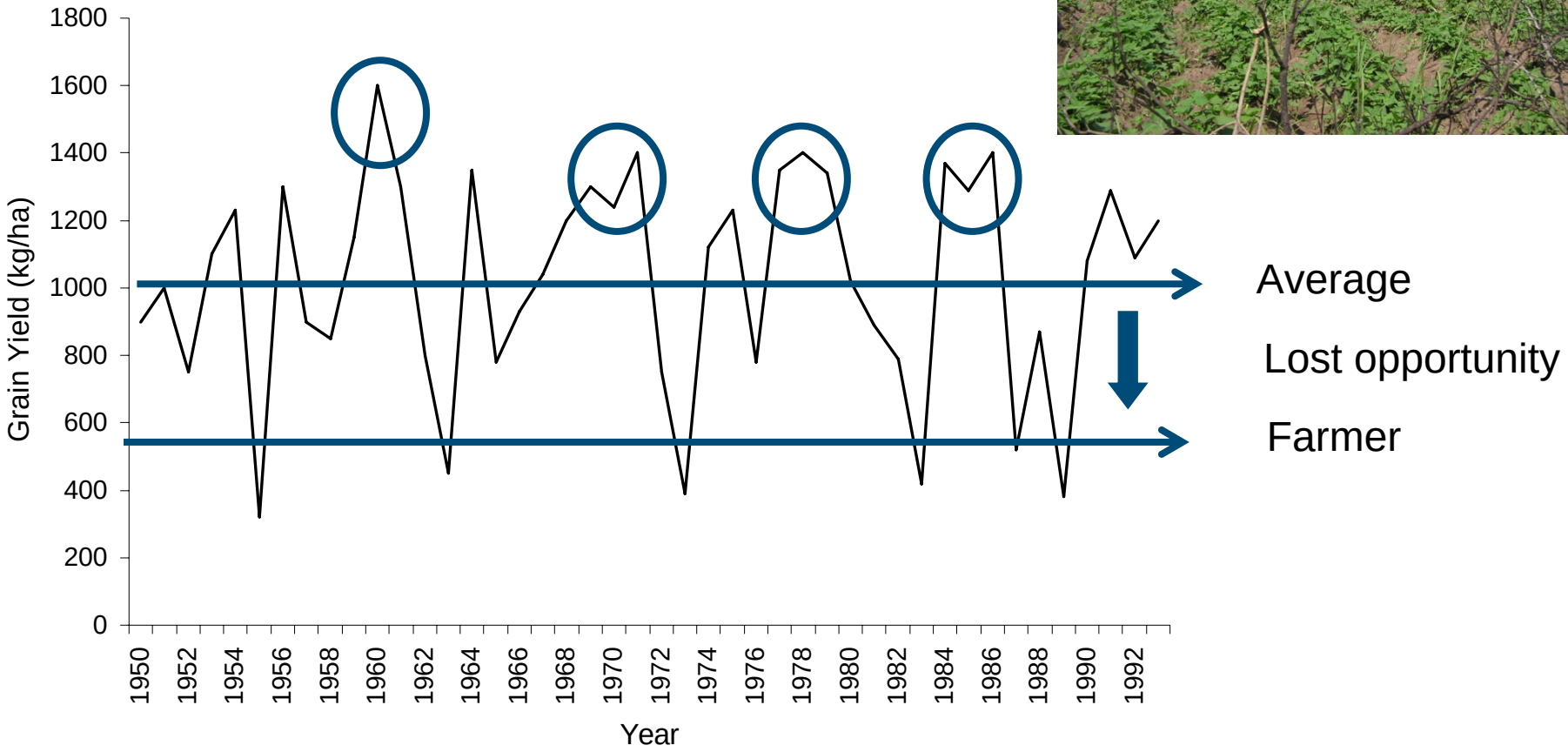
Location specific soil management

Rainfed
+ fertilizers

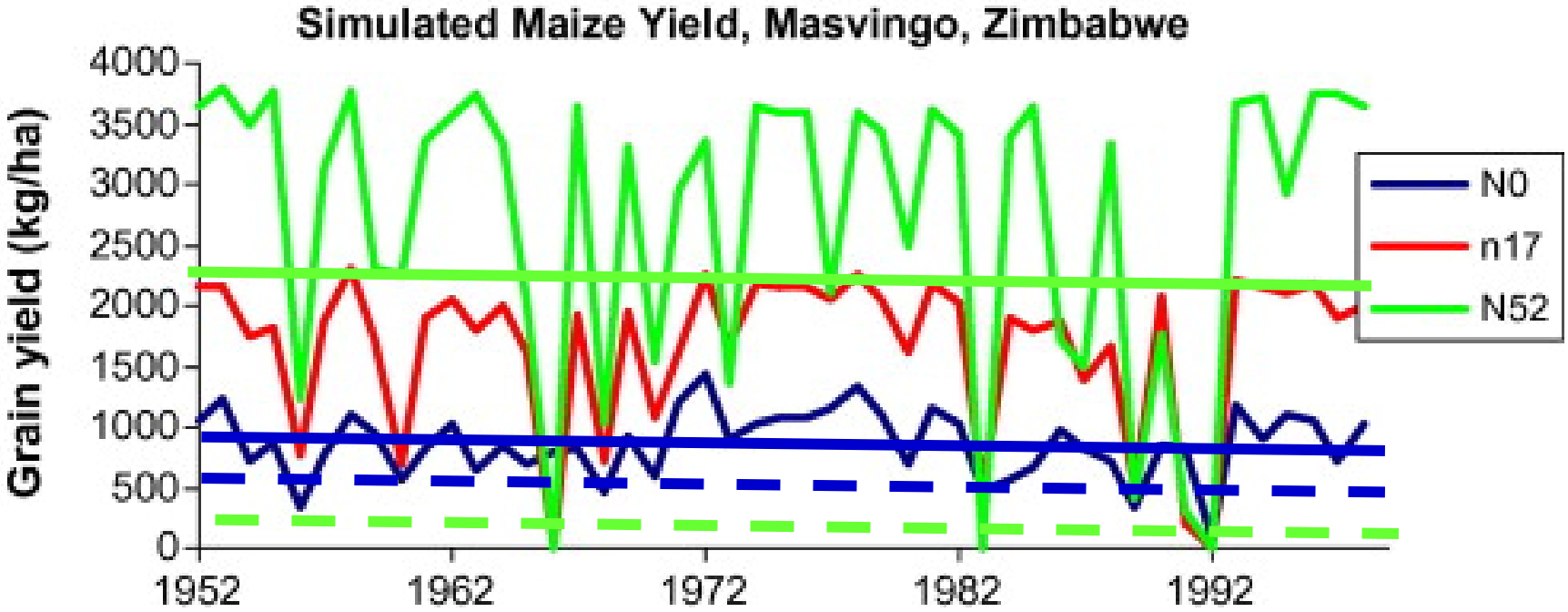
Rainfed
- fertilizers



Variability



Interaction may increase variability



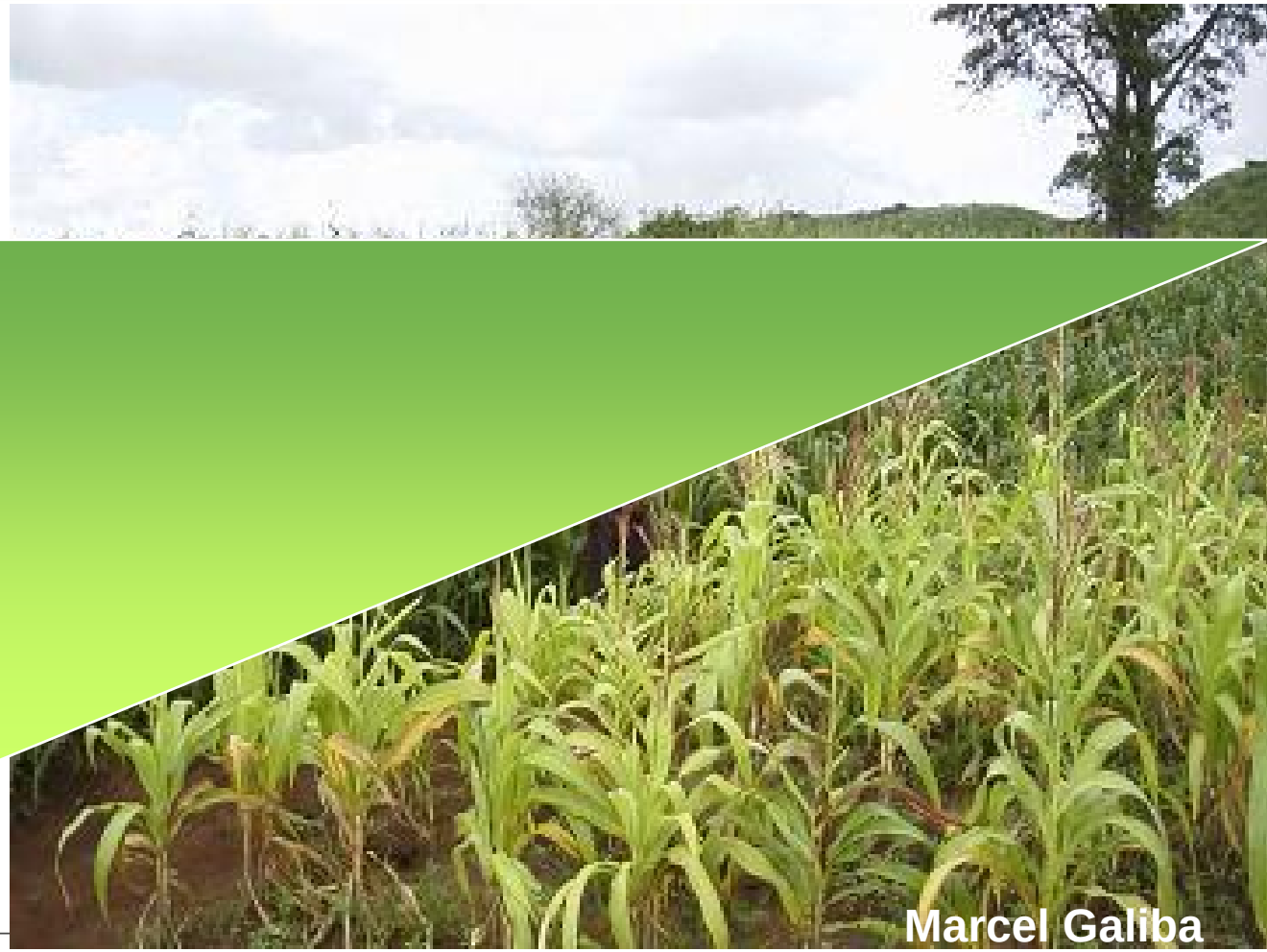
(Twomlow, Mugabe et al. 2008)

Location specific soil management

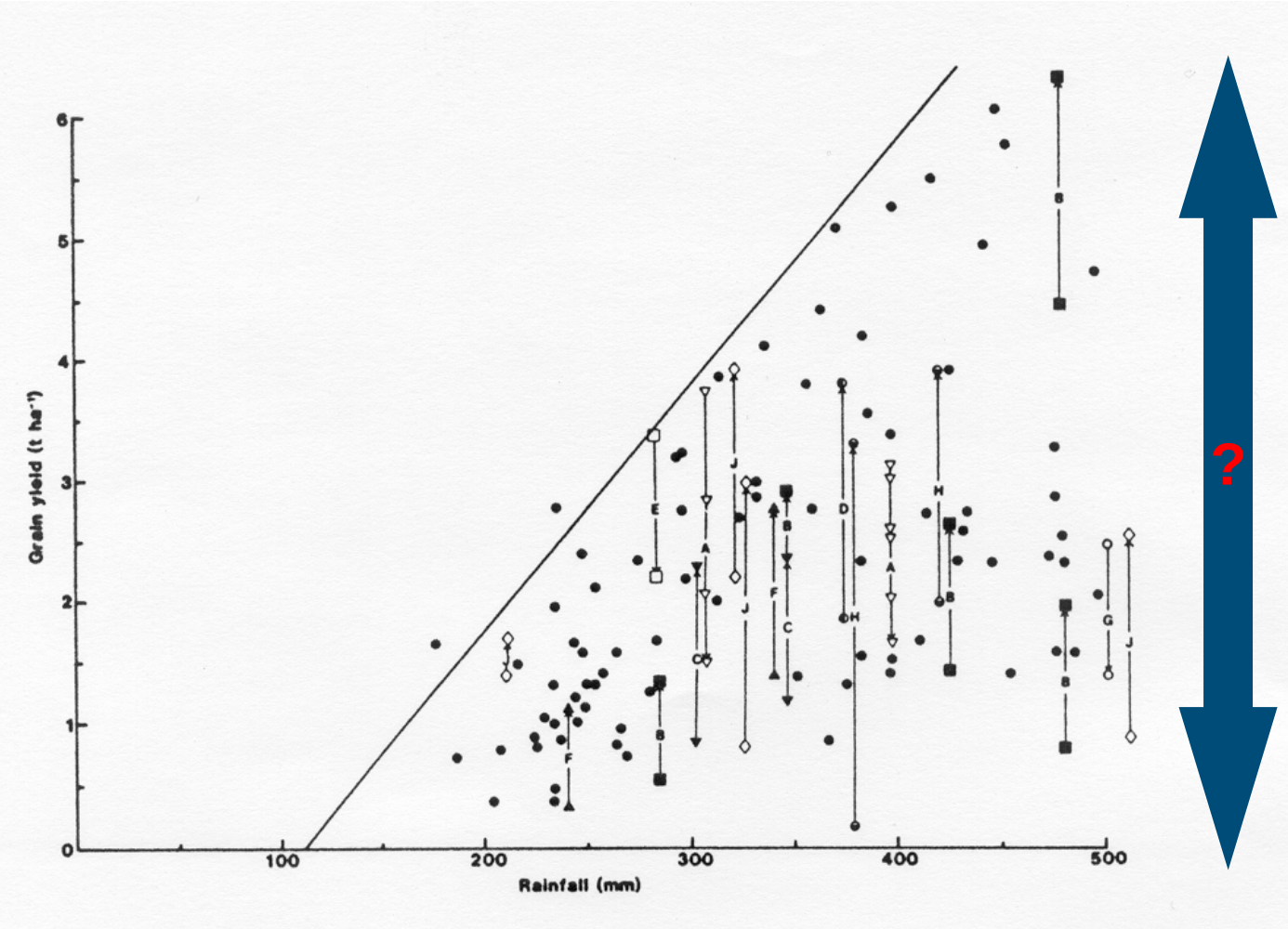
BUT NOT WITHOUT RISK!

Rainfed
+ fertilizers

Rainfed
- fertilizers



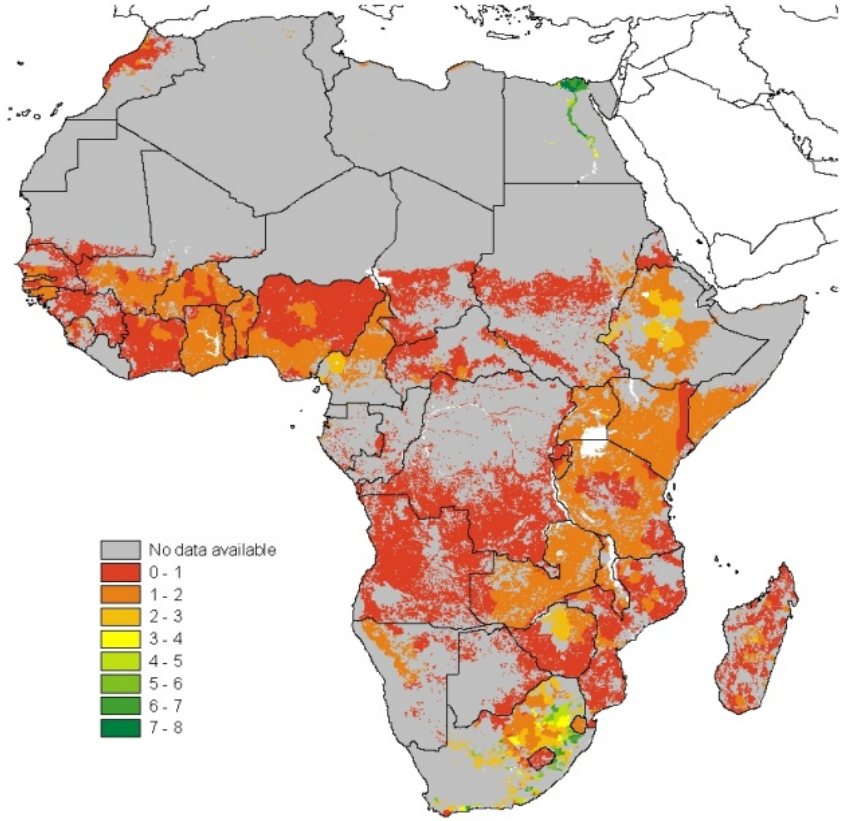
Potential in current agriculture to increase WUE



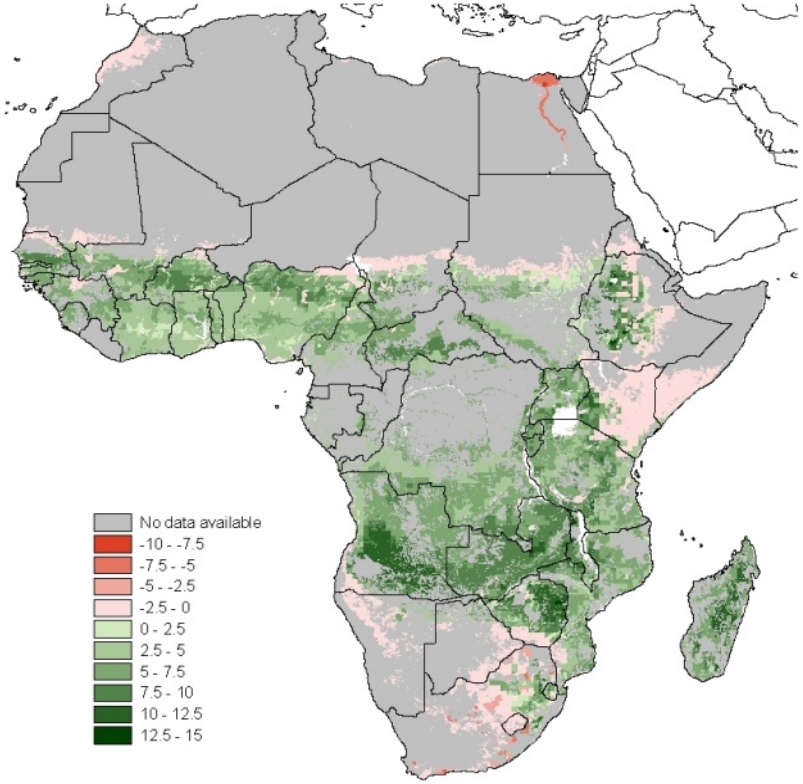
French and Schulz

Production potentials African continent

Current yield



Yield gap



ISRIC World Soil Information

Conijn, J.G., et al., 2011 (in prep)
PRI, Wageningen UR.

Managing and improving soils is complex (field)

Weeds, pests, diseases

Infestation

Rainfall
Irrigation

Variability

Water management

Erosion

Nutrient mining

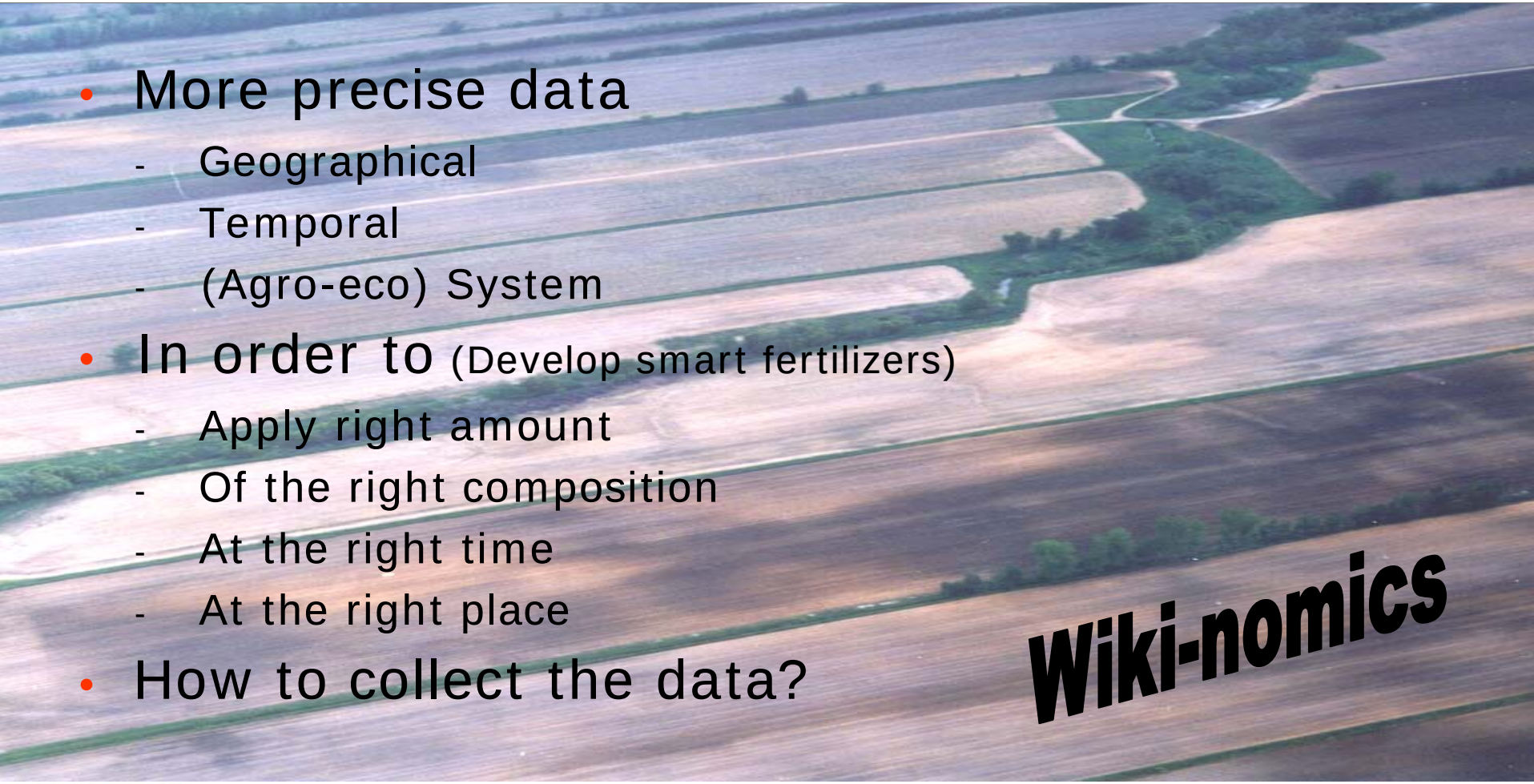
Fertilizatio n

Nutrient management

Productio n

Short and long term **Risk**

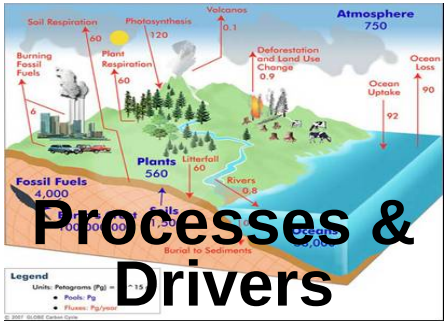
Precision



- More precise data
  - Geographical
  - Temporal
  - (Agro-eco) System
- In order to (Develop smart fertilizers)
  - Apply right amount
  - Of the right composition
  - At the right time
  - At the right place
- How to collect the data?

Wiki-nomics

Research domain



Processes & Drivers

Indicators for required soil information

Data, maps, methodologies, protocols, etc

Tools

Impact assessments

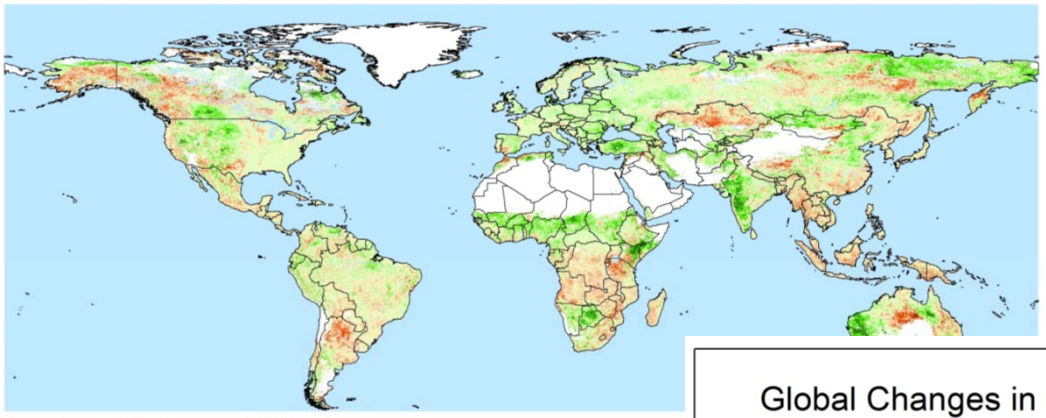
Impact

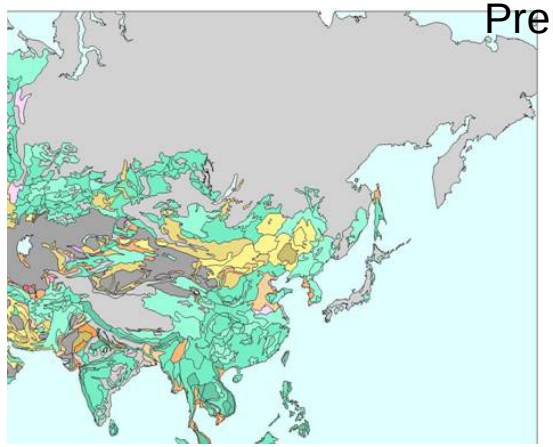
ISRIC

GLOBAL ASSESSMENT OF THE STATUS OF HUMAN-INDUCED SOIL DEGRADATION (1990)

Zhanguo Bai, Sjaak Conijn, Prem Bindraban, et al

Global Changes in Greenness by Annual Sum NDVI (1981-2006)



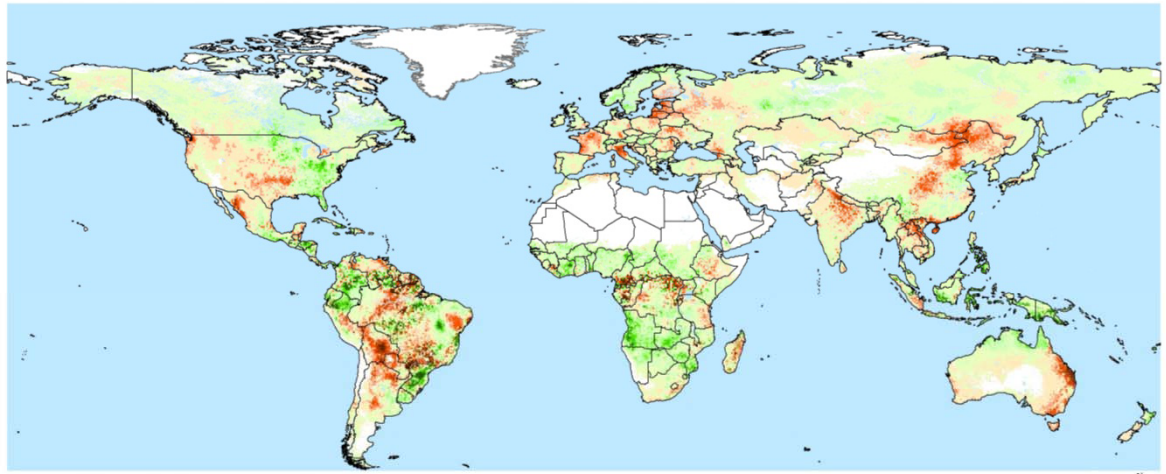


No Vegetation

Greenness Changes by Annual Sum NDV (%/year)

< -1.2	-1 - -0.8	-0.6 - -0.4	-0.2 - 0	0.2
-1.2 - -1	-0.8 - -0.6	-0.4 - -0.2	0 - 0.2	0.4

Global Changes in Calculated Rainfed Biomass Production (1981-2006)



DEGRADATION SEVERITY (Extent + Degree)

Water erosion	Wind erosion	Chemical deterioration	Physical deterioration
- Loss of topsoil - Terrain deformation/ mass movement	- Loss of topsoil - Terrain deformation - Overblowing	- Loss of nutrients/ organic matter - Salinization/alkalinization - Acidification - Pollution	- Compaction/crustin - Waterlogging - Subsidence of orga
Low	Low	Low	Low
Medium	Medium	Medium	Medium
High	High	High	High
Very high	Very high	Very high	Very high

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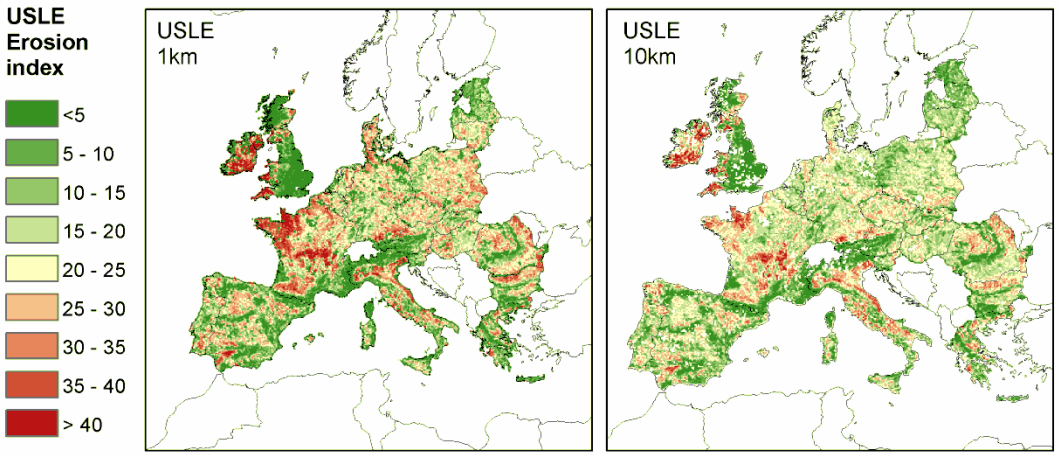
No Vegetation

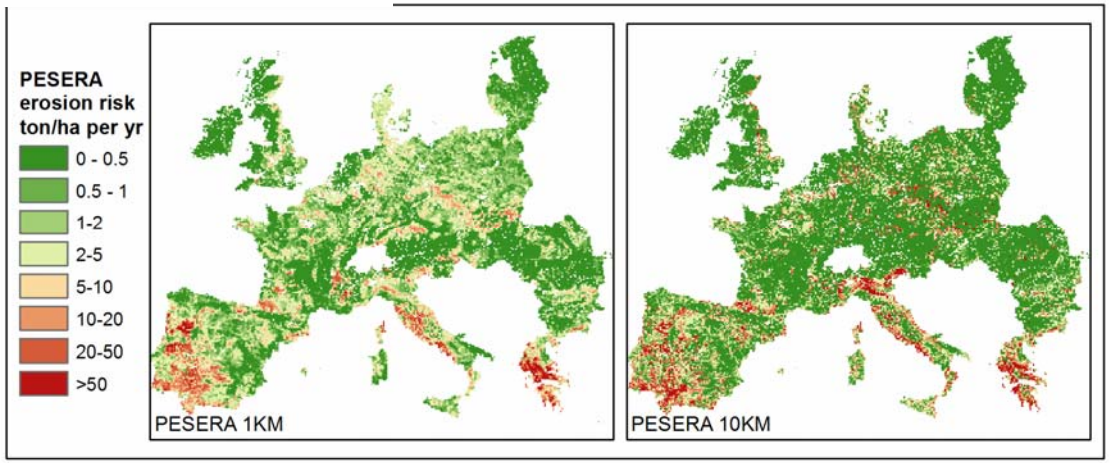
Changes in calculated rainfed biomass production of annual and perennial vegetation (1981-2006) (tonne/ha/year)

< -0.6	-0.5 - -0.4	-0.3 - -0.2	-0.1 - 0	0.1 - 0.2	0.3 - 0.4	0.5 - 0.6
-0.6 - -0.5	-0.4 - -0.3	-0.2 - -0.1	0 - 0.1	0.2 - 0.3	0.4 - 0.5	> 0.6

Water

Degradation - II

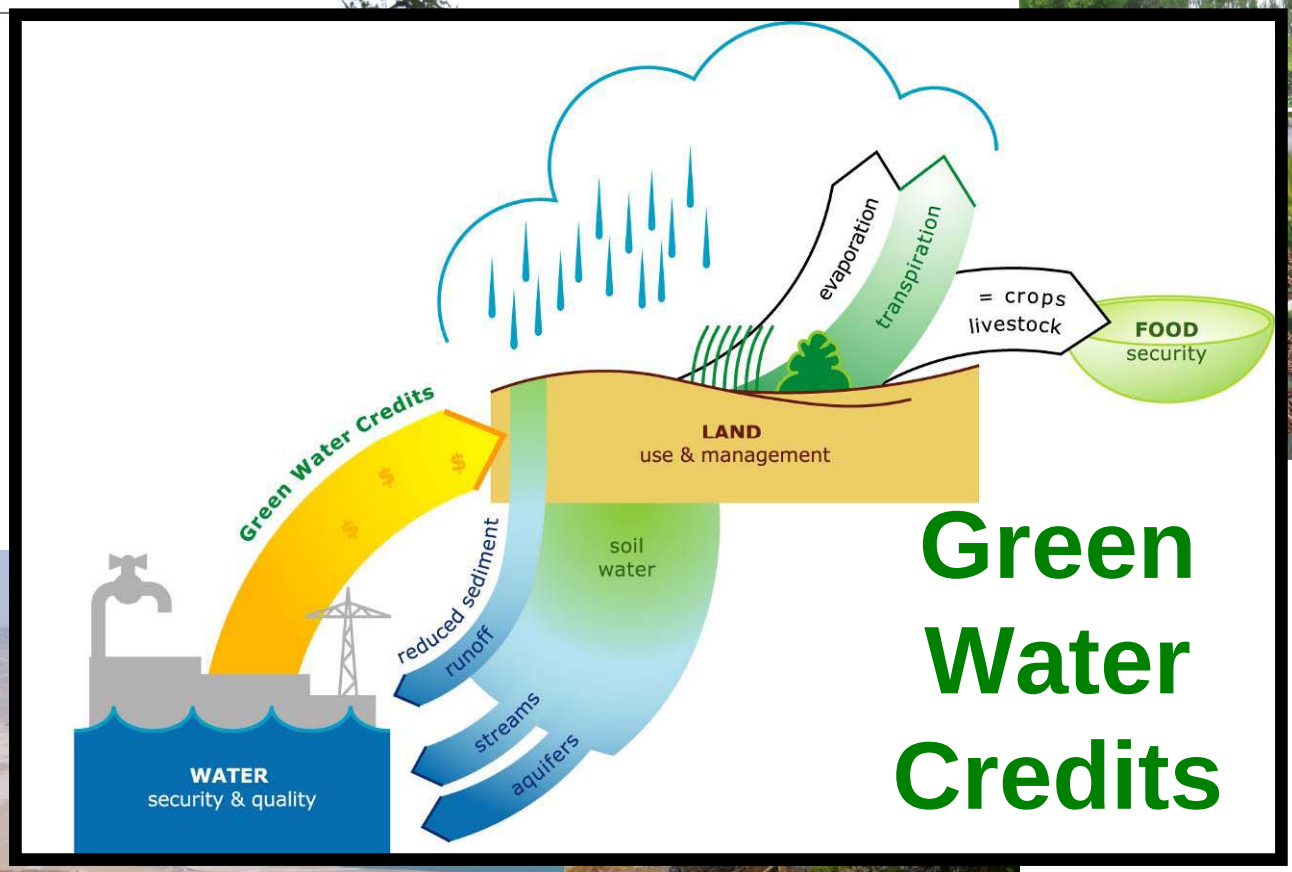




Preliminary results

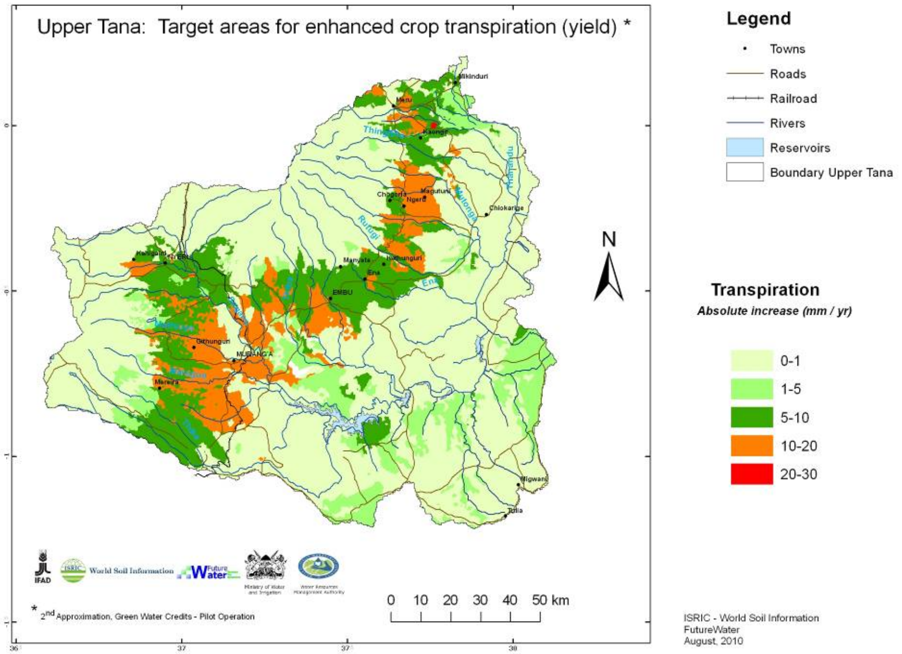
Schulp, Mantel, v.d. Berg, Bindraban

GWC – Investment mechanism



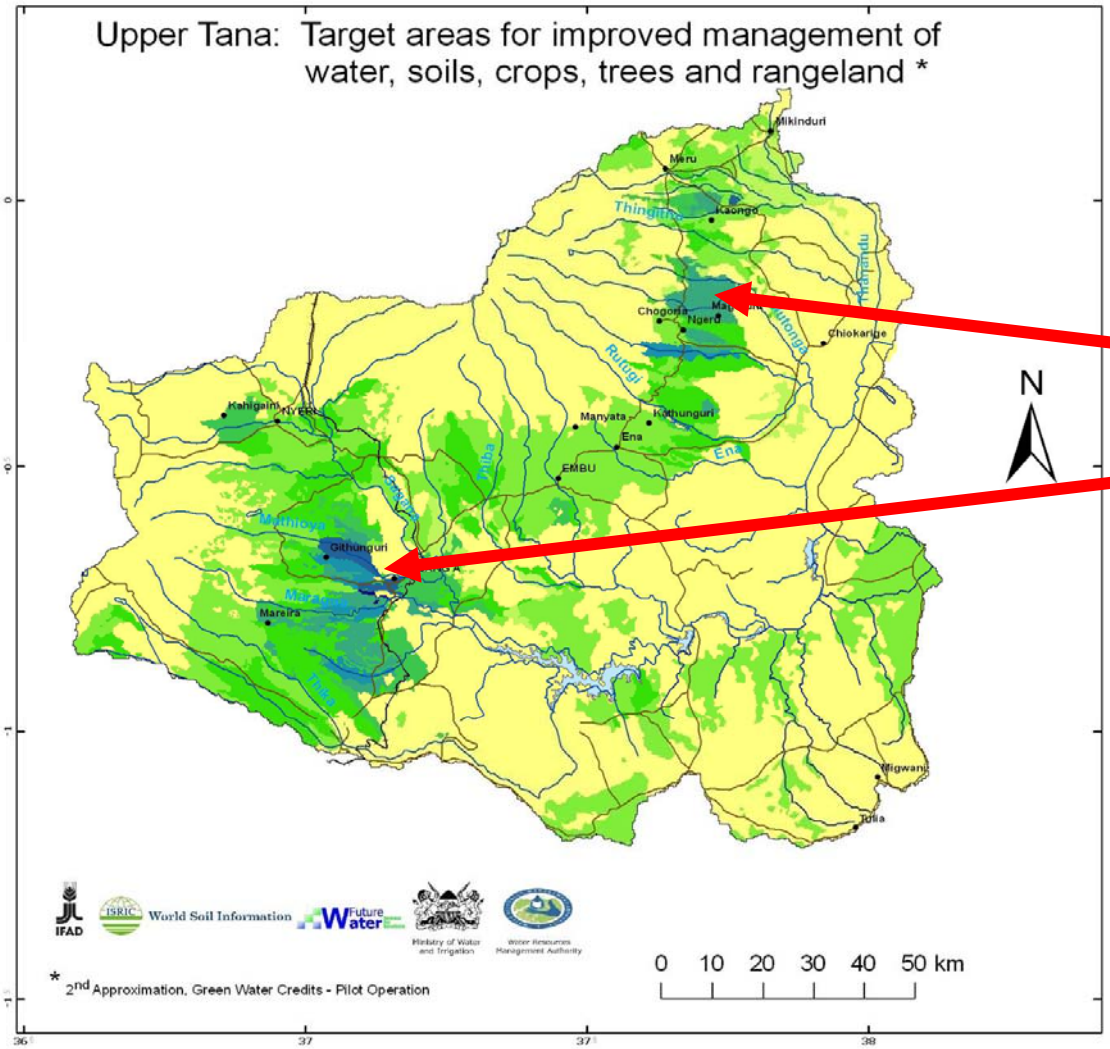
Green Water Credits

Kauffman et al.



Upper Tana: Target areas for enhanced crop transpiration (yield) *
Legend
Towns
Roads
Railroad
Rivers
Reservoirs
Boundary Upper Tana
N
Transpiration
Absolute increase (mm / yr)
0-1
1-5
5-10
10-20
20-30
0 10 20 30 40 50 km
* 2nd Approximation, Green Water Credits - Pilot Operation
EMBU
MURANG'A
IFAD
World Soil Information
FutureWater
ISRIC - World Soil Information
FutureWater
August, 2010

Green Water Credits Investment Opportunities



Legend

- Towns
- Roads
- Railroad
- Rivers
- Reservoirs
- Boundary Upper Tana

Target areas
Index

- 0.00 - 0.10
- 0.10 - 0.50
- 0.50 - 0.60
- 0.60 - 0.65
- 0.65 - 0.70
- 0.70 - 0.75
- 0.75 - 0.80
- 0.80 - 0.85
- 0.85 - 0.90
- 0.90 - 1.00

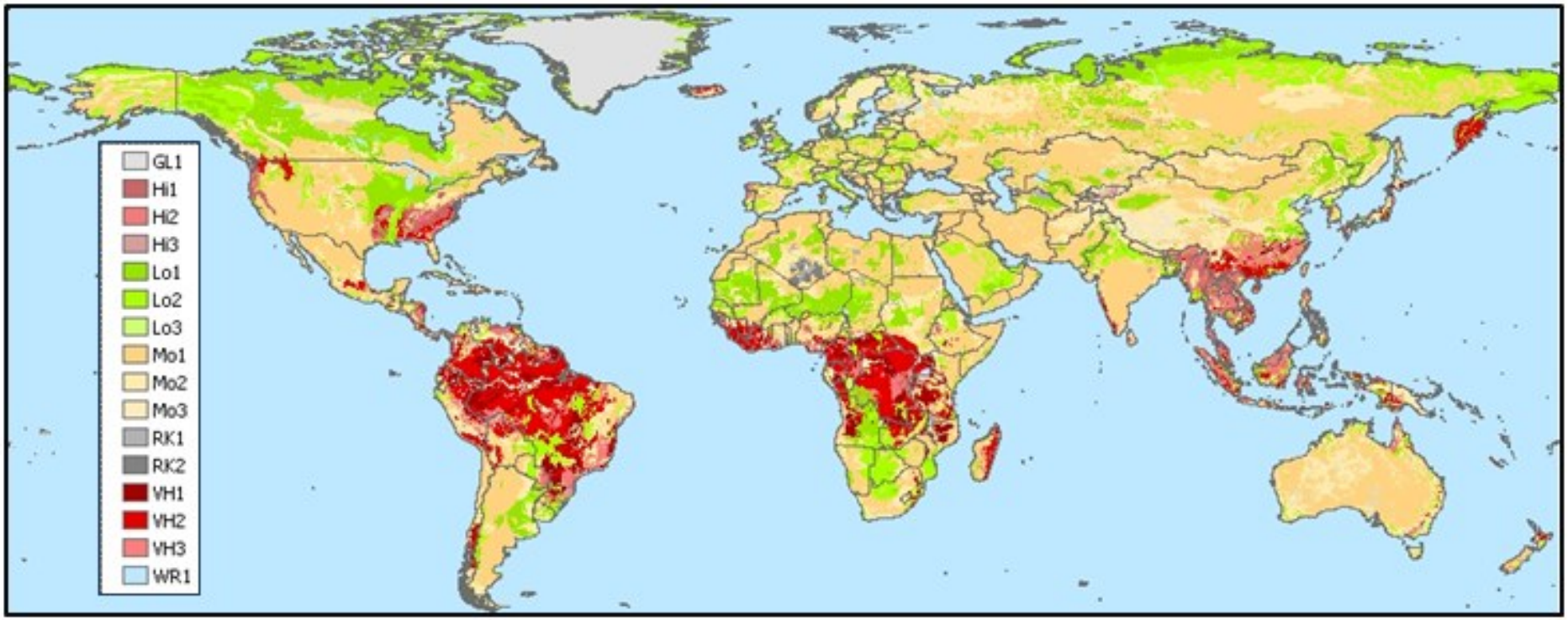
ISRIC - World Soil Information
FutureWater
August, 2010

Highest return/impact on investment/ intervention expected.

Green Water Credits portfolio

- Kenya – Implementation
- Morocco – Demonstration
- Algeria – Proof of concept
- Tunisia – Proof of concept
- China – Proof of concept
- EU countries – Identify business cases

P - retention

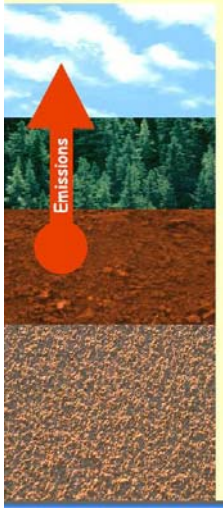


Generalized map of soil phosphorus retention potential (Map does not include Antarctica; see ISRIC Report 20011/06 for legend)

Soil Carbon and Land Use Change

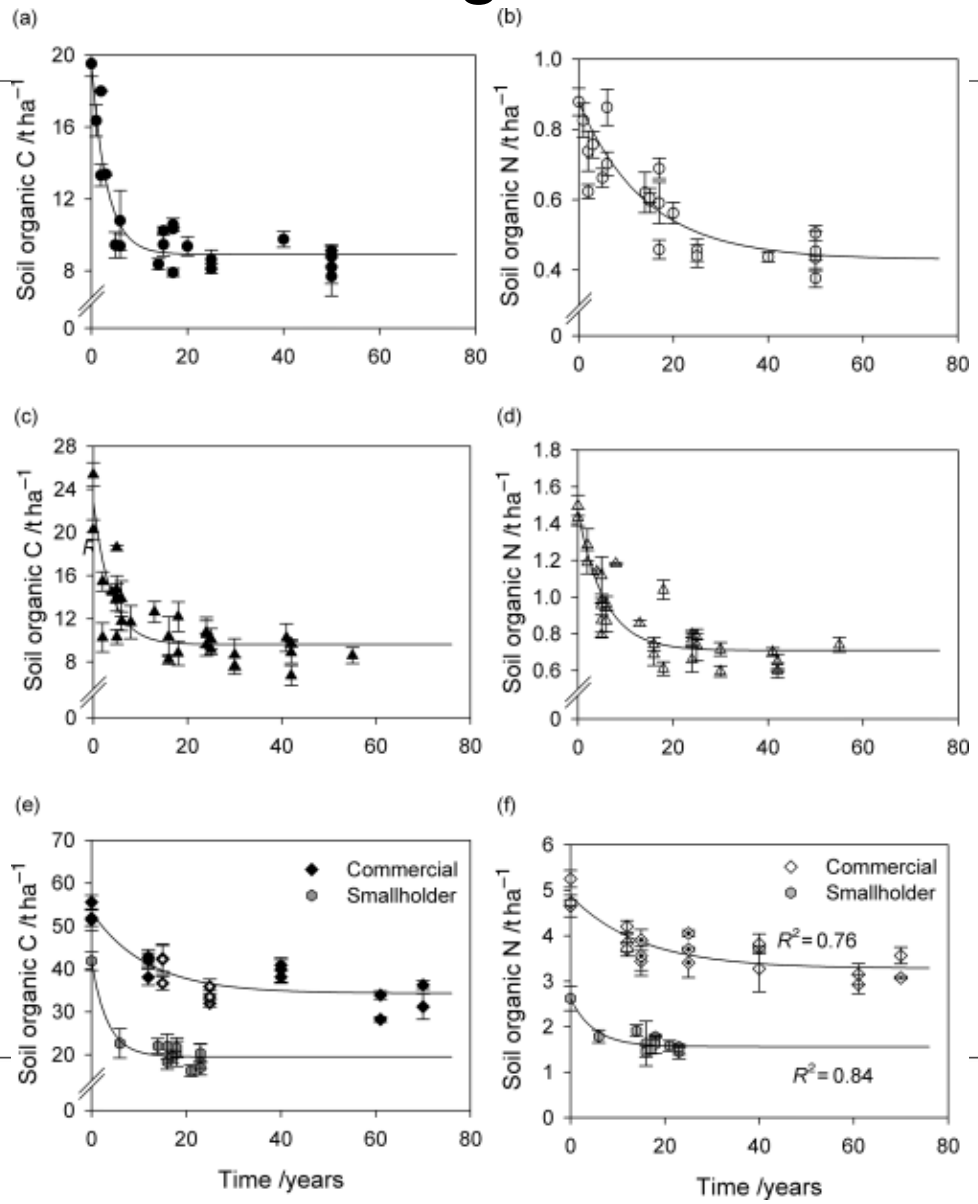
Soil Organic Carbon Stocks/Sequestration and Greenhouse Gas Emissions

Importance of SOC at global scale



	Pg
Atmosphere	730 + Δ
Vegetation	470-655
Soil (0-30cm)	~700
Soil (1m)	1500-2000

Values in Gt C (1Gt = 10^9 t = 1 Pg)

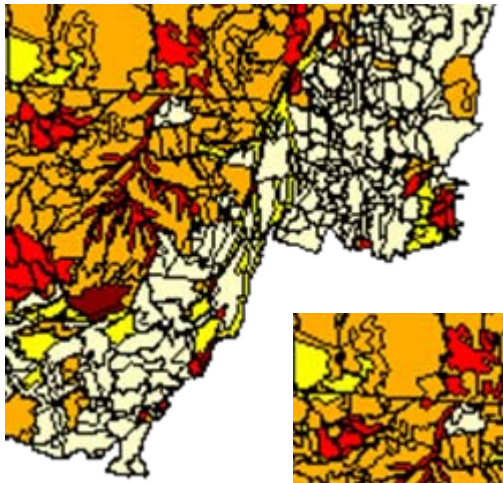


Zingore, 2007

Soil Carbon Modelling

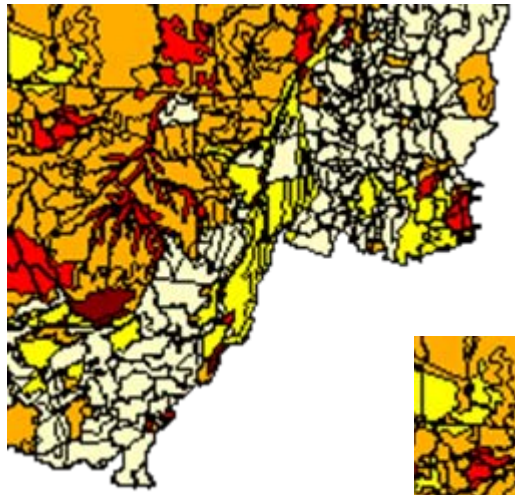
SOC stocks (t C ha^{-1})

- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100
- 100 - 150
- 150 - 250



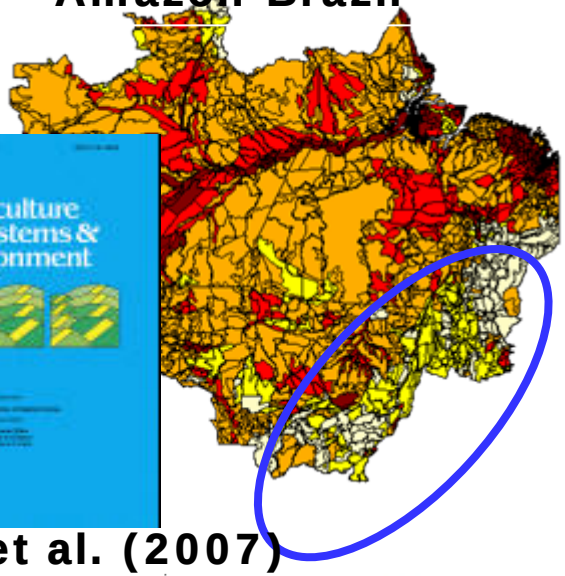
1990

Kyoto Protocol; policy makers



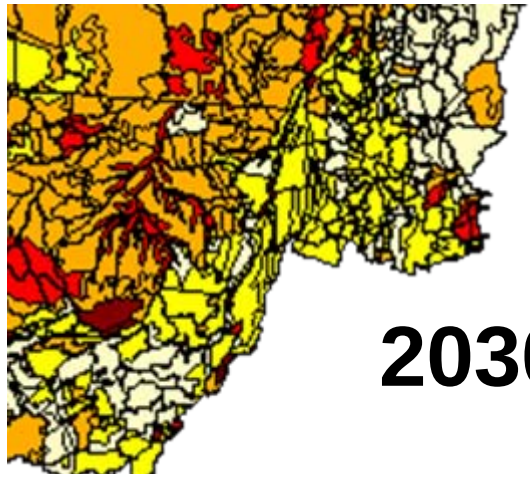
2000

Amazon-Brazil



Milne et al. (2007)

Modelled SOC stocks in the 0-20 cm soil layer



2030

Soil Carbon and Land Use Change

IPCC 2006 Climate zone	IPCC soil class																	
	Descr. statistics	HAC soils (HAC)			LAC soils (LAC)			Sandy soils (SAN)			Spodic soils (POD)			Volcanic (VOL)			Wetland soils (WET)		
T1 – Tropical Montane	n, Mean, SD	114	51	28	84	44	22	11	52	30	-		10	96	48	12	82	73
	n, Median, MAD	114	46	20	84	36	12	11	47	14	-		10	74	16	12	58	36
	IPCC2006 default [a]		88*[c]			63*			34*		na			80*			86	
T2 – Tropical Wet	n, Mean, SD	137	60	30	271	52	25	43	46	31			14	77	40	33	49	27
	n, Median, MAD	137	53	19	271	46	16	43	41	22			14	66	22	33	49	16
	IPCC2006 default [a]		44			60			66		na			130*[c]			86	
T3 – Tropical Moist	n, Mean, SD	226	40	22	326	38	19	76	27	15	-					55	68	45
	n, Median, MAD	226	35	14	326	33	12	76	23	11	-					55	53	24
	IPCC2006 default [a]		65			47			39		na			70*			86	
T4 – Tropical Dry	n, Mean, SD	554	21	13	135	19	11	164	9	5	-					32	22	11
	n, Median, MAD	554	17	7	135	17	7	164	8	3	-					32	20	7
	IPCC2006 default [a]		38			35			31		na			50*			86	
W1 – Warm Temp. Moist	n, Mean, SD	489	64	33	183	55	29	39	36	26	9	143	65	42	138	56	28	135	101
	n, Median, MAD	489	59	21	183	50	19	39	29	11	9	142	54	42	143	28	28	94	49
	IPCC2006 default [a]		88			63			34		na			80			88	
W2 – Warm Temp. Dry	n, Mean, SD	781	24	16	41	19	10	338	10	5	-		10	84	88	49	74	45
	n, Median, MAD	781	19	9	41	18	7	338	9	3	-		10	33	23	49	66	34
	IPCC2006 default [a]		38			24			19		na			70*			88	
C1– Cool Temp. Moist	n, Mean, SD	334	81	40	6	76	48	126	51	39	45	128	61	28	136	52	42	128	55
	n, Median, MAD	334	74	28	6	66	18	126	42	22	45	115	41	28	137	28	42	113	36
	IPCC2006 default [a]		95			85			71		115			130			87	
C2– Cool Temperate Dry	n, Mean, SD	177	43	24		-		10	13	7	-			-			-	
	n, Median, MAD	177	38	17		-		10	12	3	-			-			-	
	IPCC2006 default [a]		50			33			34		Na			20*			87	
Bx – Boreal (undiff.) [d]	n, Mean, SD	35	63	34		-			-		-			-		6	116	94
	n, Median, MAD	35	58	22		-			-		-			-		6	110	76
	IPCC2006 default [a]		68			na			10*		117			20*			146	
Px – Polar (undiff.) [d]	n, Mean, SD	24	59	61		-		18	27	29	-			-			-	
	n, Median, MAD	24	30	27		-		18	14	12	-			-			-	
	IPCC2006 default [a]		-			-		-			-			-			-	

Source: *AGEE* (2011) **142** 365-373

Farmer recommendations ...

Fertilizer N use efficiency = 50 kg grain/kg N

Fertilizer N use efficiency = 50 kg grain/kg N

Fertilizer N use efficiency <5 kg grain/kg N

Slide Ken Giller (Wageningen UR)

Think globally – Act locally

We can do this – through collaboration and sharing of information

ISRIC World Soil Information

WAGENINGEN UR
For quality of life