Functionally context socio-ecological type (fCSET) approach to support outscaling of agricultural innovation options

Quang Bao Le et al.

Mind the Gap Project, Final Workshop

11-12 November 2019, Hammamet, Tunis

ICARDA

Science for resilient livelihoods in dry areas

Problems

- High contextual diversity of drylands *vs.* “uniform blanket” approach in promoting site-specific project findings on sustainable land management (SLM) options over large scales

- Lack of tool supporting comparative analyses/assessments of successful SLM options by context, thereby supporting out-scaling efforts

Objective

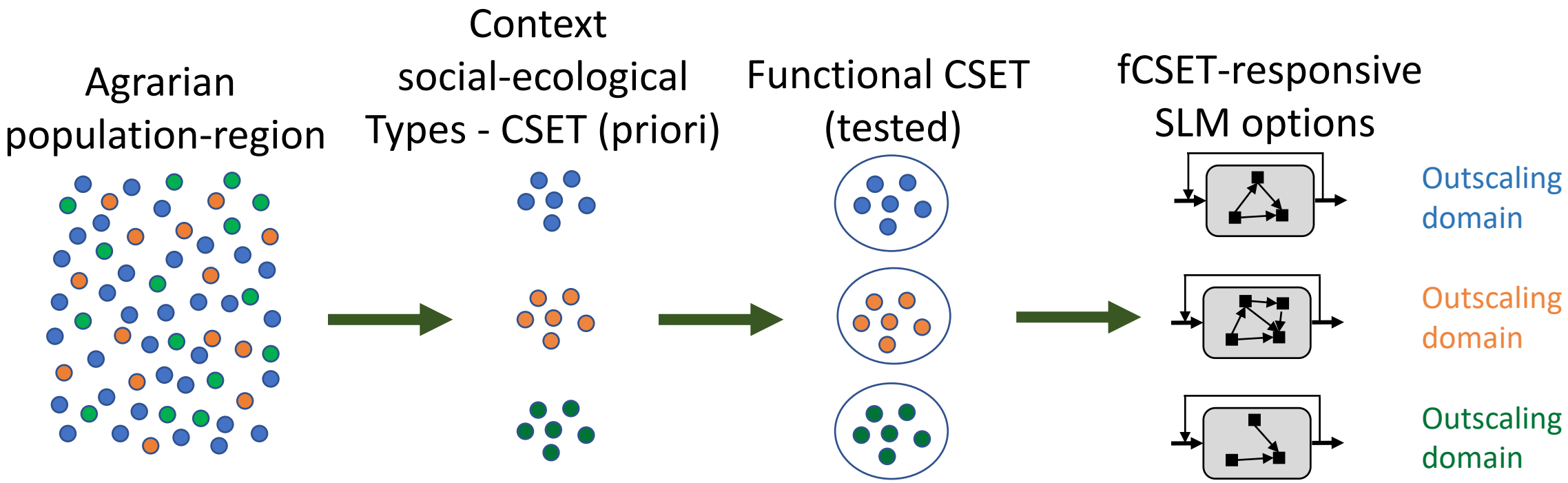
- To provide land users, projects/programs and policy decision-makers with plausible, robust extrapolation domains for guiding efforts and decisions on out-scaling of SLM options

Concept of Functional Context Social-Ecological Type (fCSET) as Geographic Extrapolation Domain

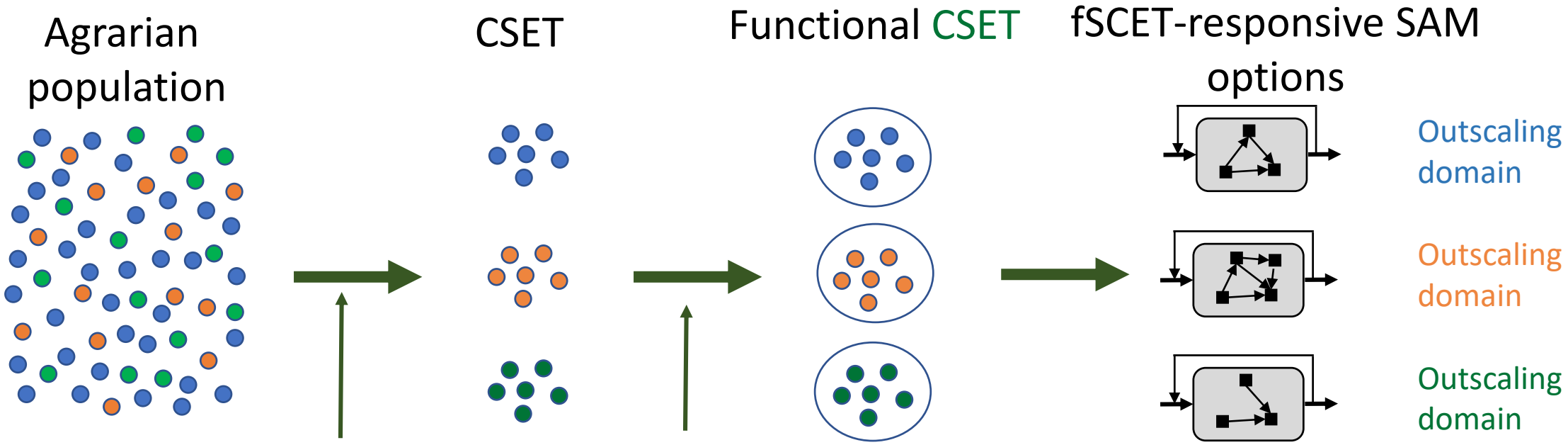
- Contextual socio-ecological type (CSET): a set of contextual factors, including driving forces and boundary conditions which ***potentially*** shape the interactions between land/agricultural system's structure/functions with management interventions in resulting the system performance.

- Functional contextual socio-ecological type (fCSET): CSET which influences the land-use system performance.
  - Land productivity/crop yield trend
  - Productivity gap (= actual prod./potential prod.)
  - Biomass reserves needed for maintaining ecosystem services
  - Innovation adoptions
  - Etc.

fCSET approach: capture and manage contextual diversity



Defining and mapping fCSET - How?



CATEGORIZING DATA

- Current knowledge of potential drivers + data availability
- Multivariate descriptive statistics (principal component analysis - PCA, cluster analysis - CA)

TESTING - DISCOVERING

- Check if performance indicators are different among CSETs
- Use independent data
- ANOVA, regression analysis

MAPPING fCSET for uses as potential extrapolation domain

Multi-disciplinary data used

Integrated, pixel-based database
(28 variables)

Contextual variables (potential drivers) of land-use system's performance

Biophysical
(17 varirables)
- ✓ Climatic (3)
- ✓ Topographic (2)
- ✓ Land cover/use (2)
- ✓ Soil quality constraints (7)
- ✓ Livestock densities (3)

Accessibilities
(3 variables)
- ✓ Distance to road
- ✓ Distance to town
- ✓ Distance to water body

Population Pressure
(3 variables)
- ✓ Pop density
- ✓ Rural pop density
- ✓ Pop density change

Economic Development
(2 variables)
- ✓ Gridded GDP per capita
- ✓ Gridded GDP growth

25 contextual variables used to classify CSETs

Proxies of land-use system's performance

Biomass productivity Trend
- ✓ Periodic trend of NPP

Biomass productivity Gap
- ✓ NPP gap = actual NPP/potential NPP

Pressure of human uses on biomass needed for ESS
- ✓ Human appropriation of NPP = used NPP/natural NPP

3 performance variables used to test CSETs' functionality

Structure of integrated, pixel-based database

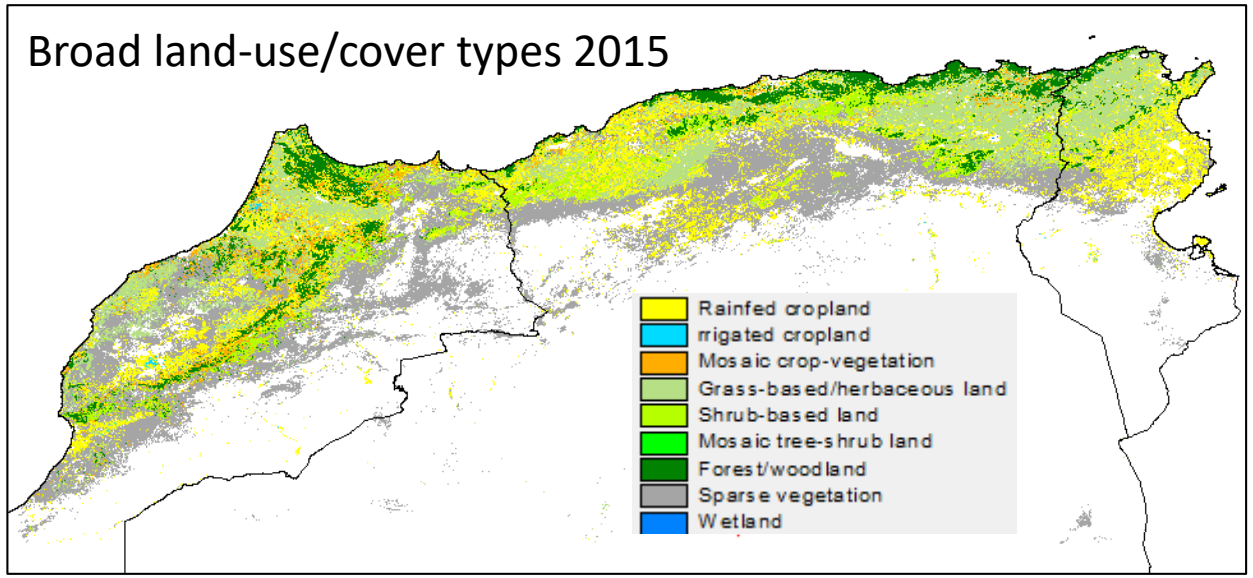
Variables of geographic coordinates allow import every variables (input or output) back to GIS program

Each column is data of a GIS variable/layer

Each row is a list of multi-disciplinary data on a 1 km^2 pixel

	X	Y	COUNTRY	COVER_LUSE	PREC_MEAN	PREC_TREND	HUMIDITY	ELEVATION	SLOPE_DEG	SQC_
2359865	3.1100	36.1439	4	3000	491	-2	.51	834	5.73	
2359866	3.1600	36.1439	4	3000	491	-1	.46	689	2.75	
2359867	3.1683	36.1439	4	3000	491	-1	.45	676	1.21	
2359868	3.1933	36.1439	4	3000	491	-1	.48	828	1.40	
2359869	3.2183	36.1439	4	3000	491	-1	.49	842	2.67	
2359870	3.2267	36.1439	4	3000	491	-1	.49	849	2.75	
2359871	3.2350	36.1439	4	3000	491	-1	.49	878	1.48	
2359872	3.2850	36.1439	4	3000	491	-1	.47	820	1.25	
2359873	3.3350	36.1439	4	3000	491	-1	.44	707	.37	
2359874	4.5850	36.1439	4	3000	519	0	.57	1413	11.71	

Starting point of fCSET analysis: Land use/cover in 3 Magreb countries

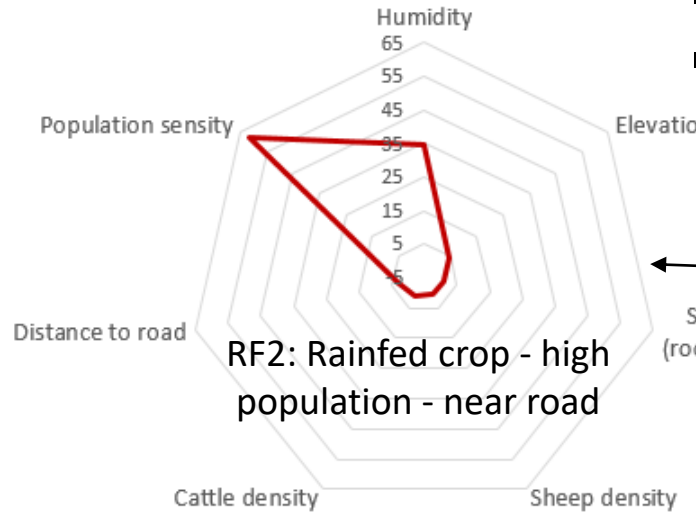


Broad land-use and cover type	% of country's total area		
	Algeria	Morocco	Tunisia
Rainfed cropland	21	17	38
Irrigated cropland	0	0	0
Mosaic crop-natural vegetation	3	8	1
Grass-based/herbaceous land	24	17	33
Shrub-based land	7	6	1
Mosaic tree-shrub land	0	0	0
Forest/woodland	9	9	6
Sparse vegetion	36	42	20
Wetland	0	0	0
Total	100	100	100

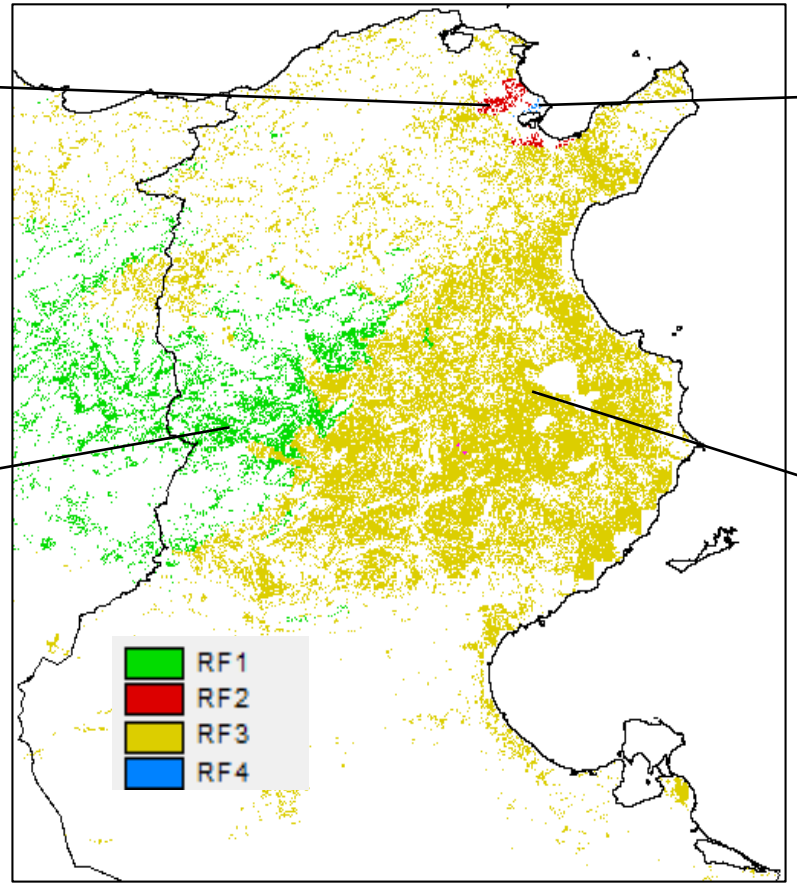
- Putting a regional perspective: not only Tunisia, but also Algeria and Morocco
- Consider major land-use/cover types:
  - Rain-fed cropland (RF)
  - Grass-based/herbaceous land (GR)

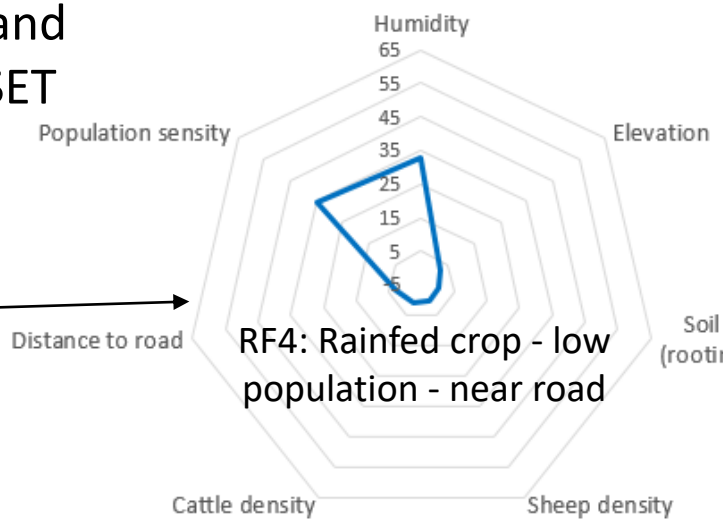
CSETs in rain-fed cropland

- Four fCSETs found in Tunisian rain-fed cropland
- fCSET name: only aspects differentiating fCSET (full profiles of 25 variables given)

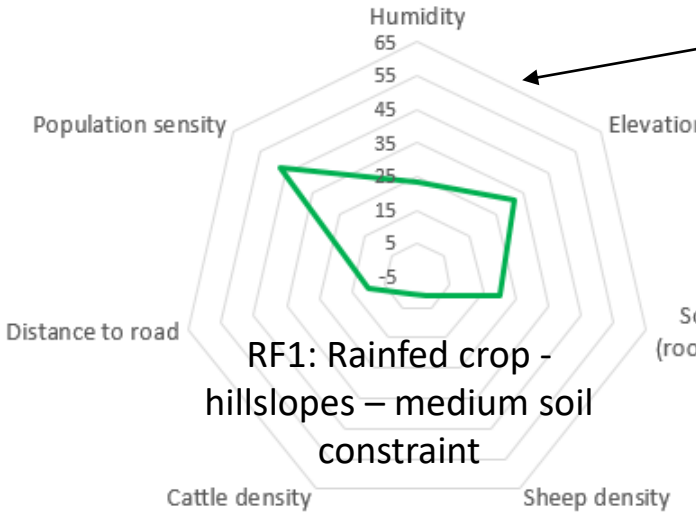


RF2: Rainfed crop - high population - near road

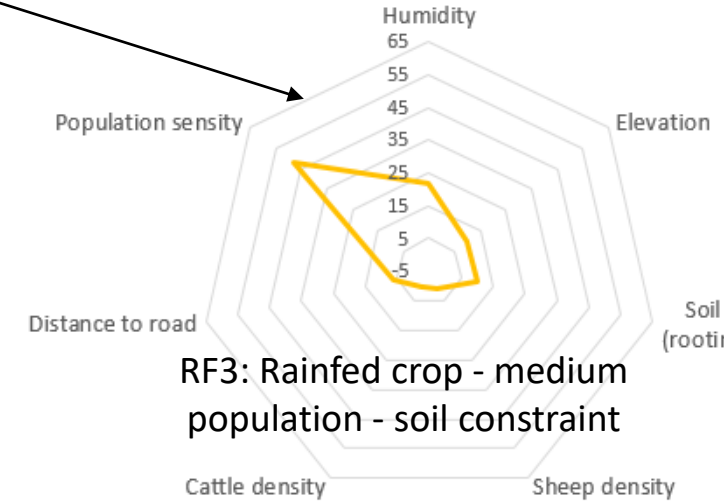




RF4: Rainfed crop - low population - near road



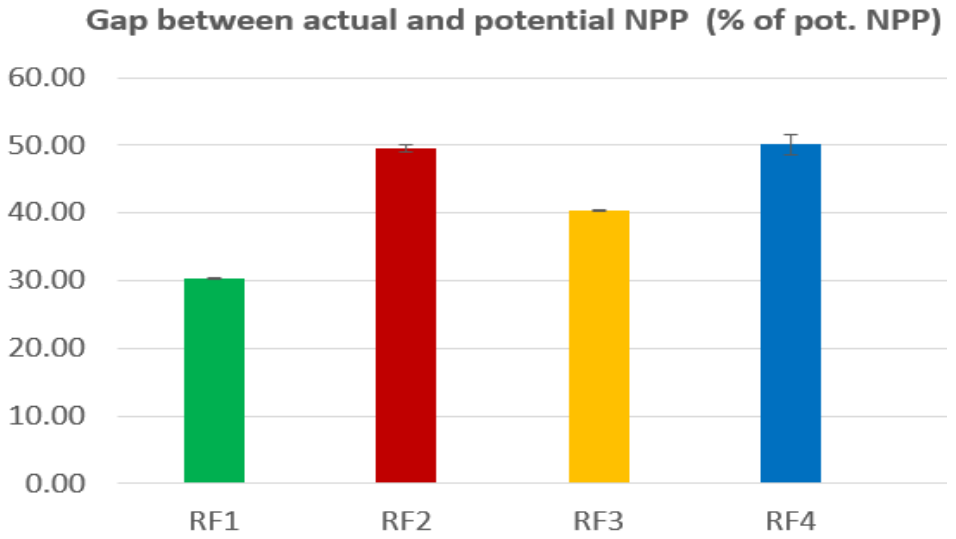
RF1: Rainfed crop - hillslopes – medium soil constraint

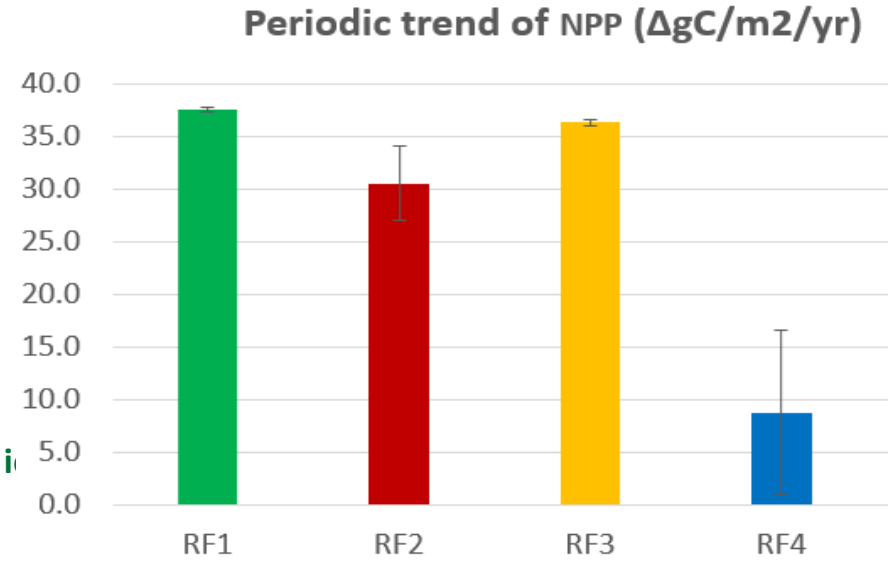


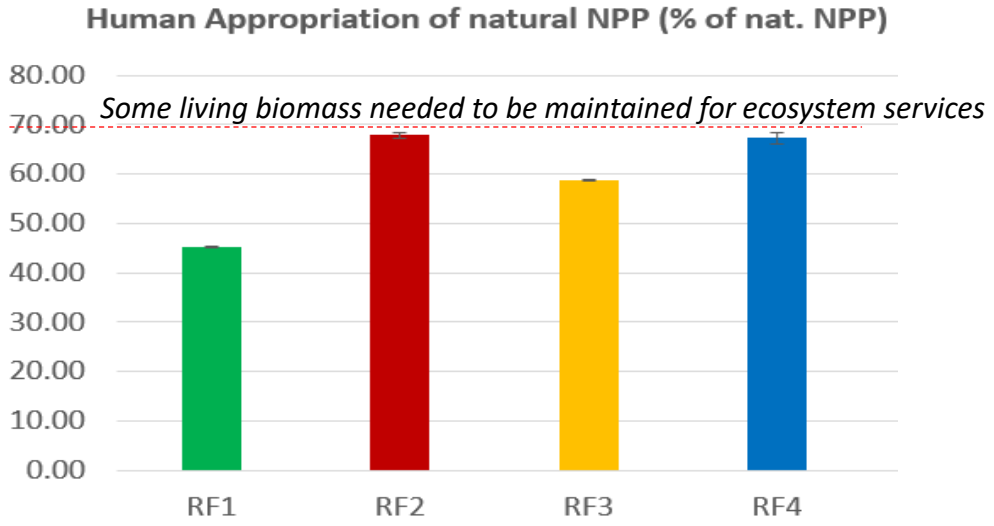
RF3: Rainfed crop - medium population - soil constraint

Testing functionalities fCSETs in rain-fed cropland

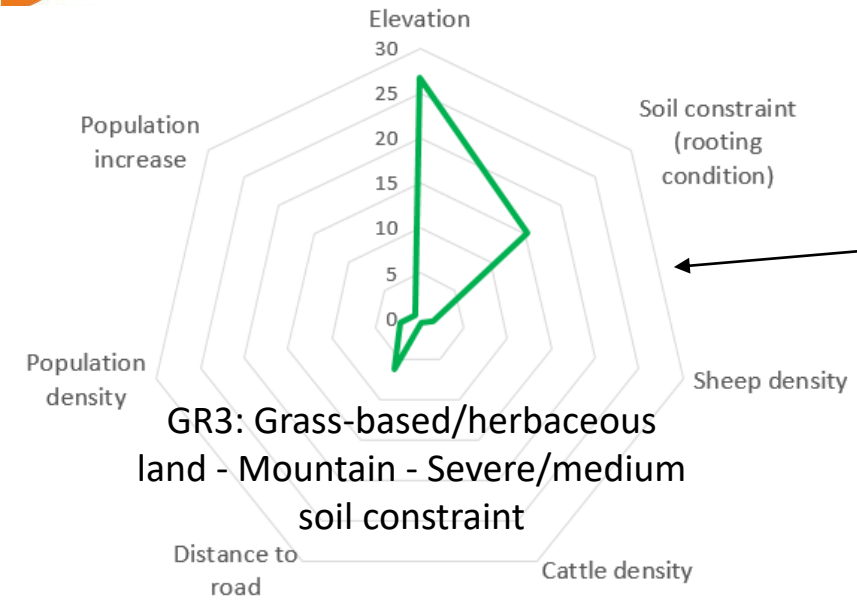
- Responses in three proxies of land degradation/improvement (trend, gap and HA of NPP) are significantly different among 4 fCSETs
- Type RF1: having the highest potential to narrow biomass productivity gap → potential for some intensification
- The other fCSETs: human appropriation approaches the threshold → conservation agriculture needed



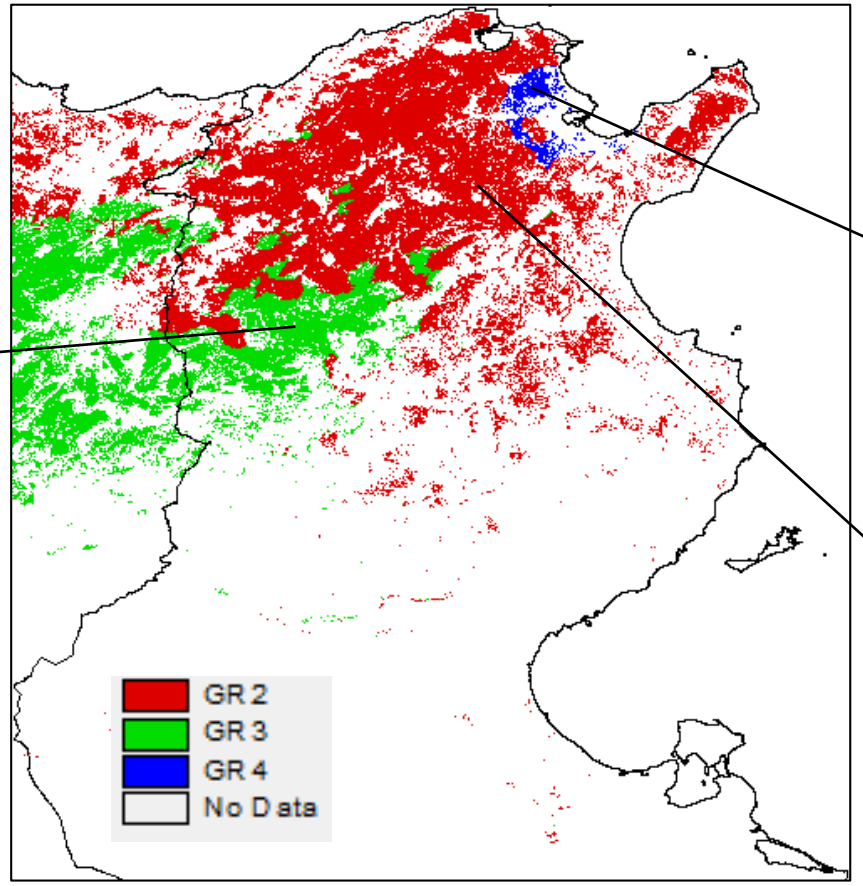


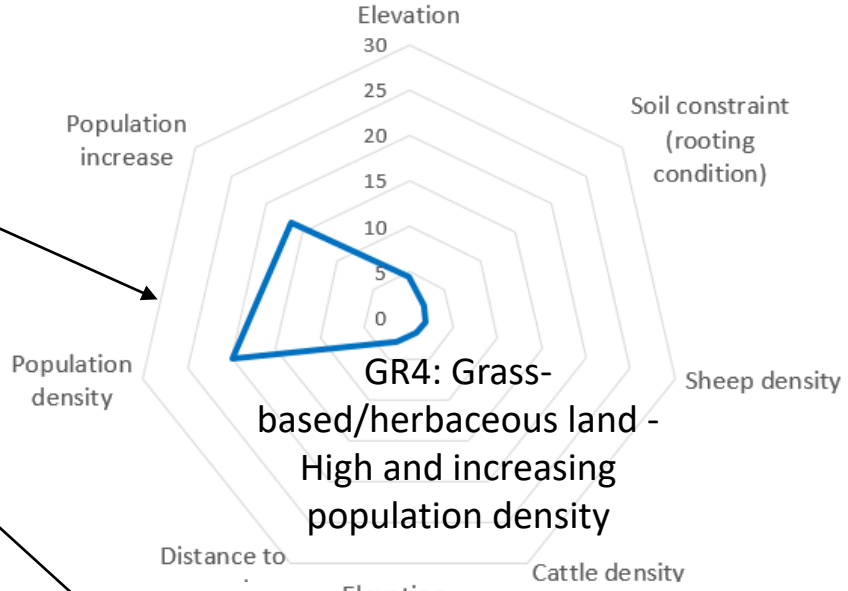


CSETs in grass-based/herbaceous land

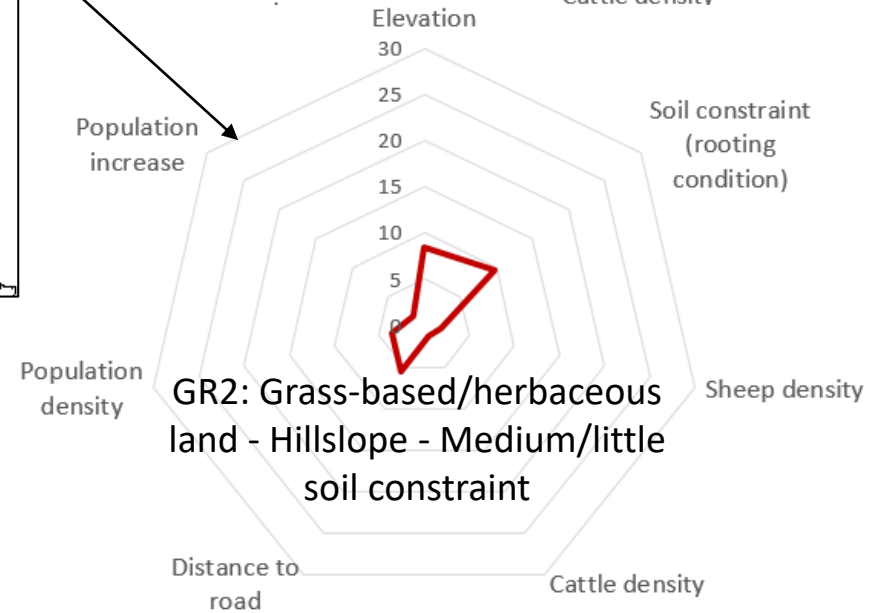


GR3: Grass-based/herbaceous land - Mountain - Severe/medium soil constraint





GR4: Grass-based/herbaceous land - High and increasing population density

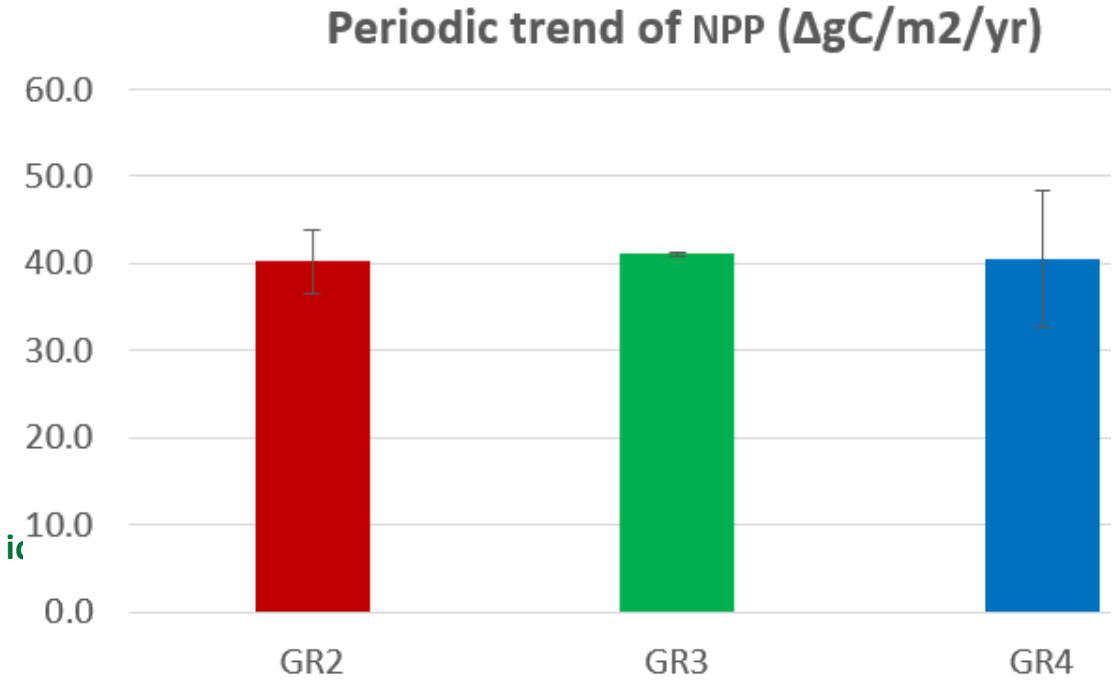


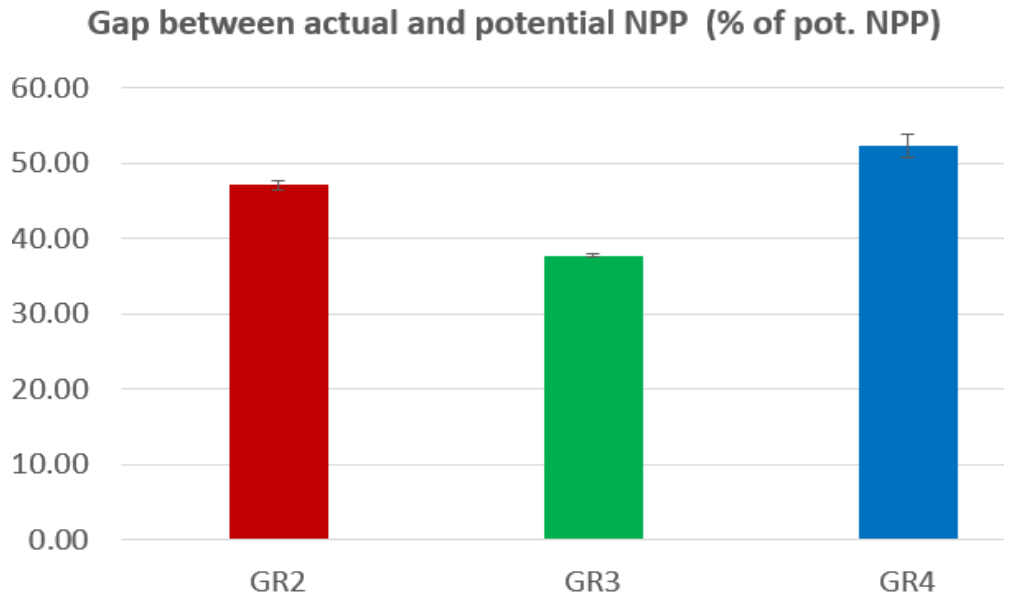
GR2: Grass-based/herbaceous land - Hillslope - Medium/little soil constraint

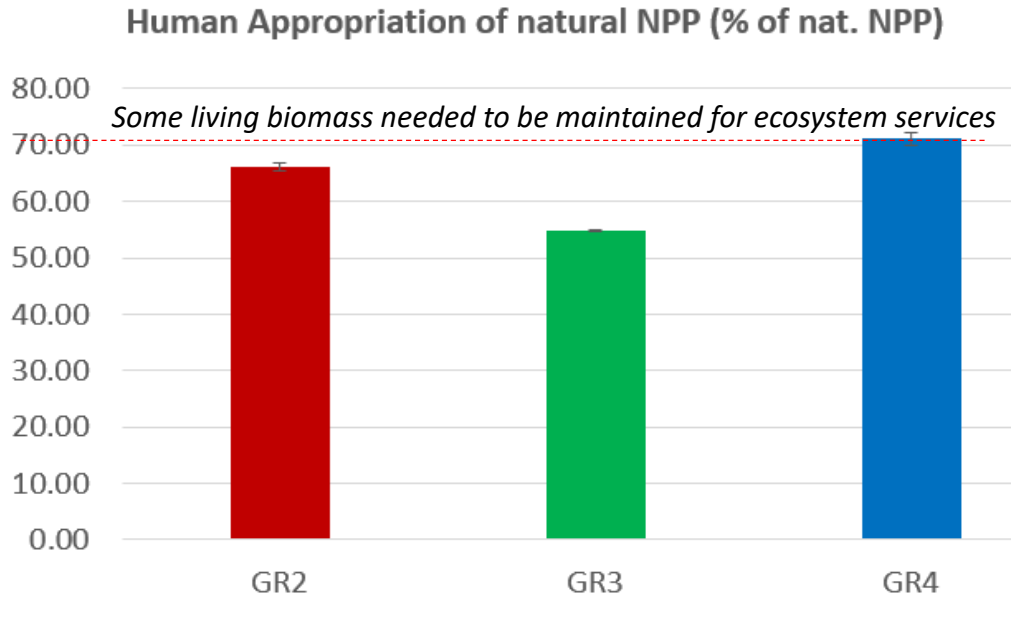
- Three fCSETs found in Tunisian grass-based herbaceous land

Testing functionalities fCSETs using in grass-based/herbaceous land

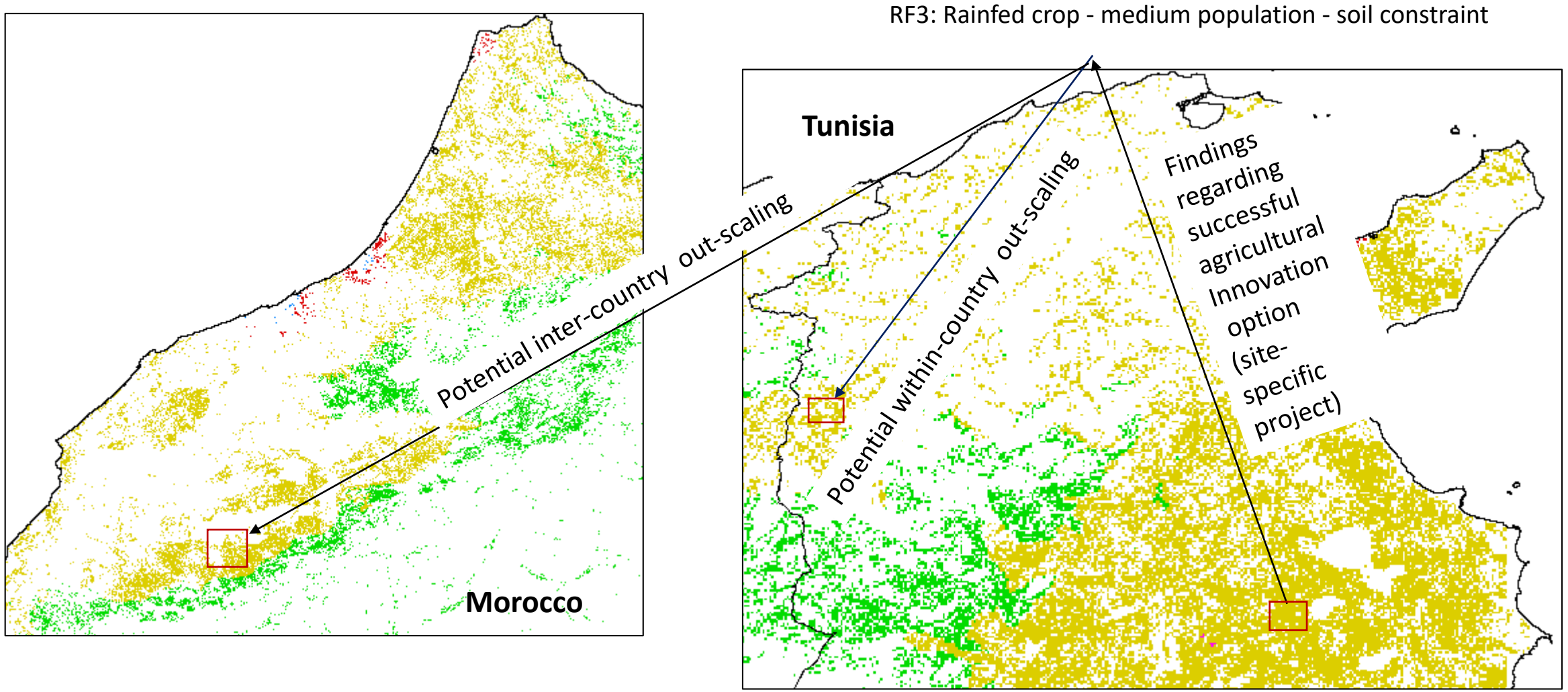
- Responses in two proxies of land degradation/improvement (gap and HA of NPP) are significantly different among 3 fCSETs
- Type GR3: having the highest potential to narrow biomass productivity gap
- Types GF2 and GR4: human appropriation approaches the threshold







Curent fCSET for supporting outscaling of site-specific findings



Limitations and Precautious Notices

- Limitations:
  - Combination of data resampled from different scales of data origins → scale mismatches can be issues
  - Mismatch of timing when data collected/generated
  - Huge very dryland in the NA continent contaminated comparative analysis → better masking would help

- Current fCSETs can help
  - Narrowing geographic consideration in out-scaling,
  - Offering relevant hypotheses for testing;
  - The integrated, pixel-based database is available for partners' organizations, follow-up projects

- Current fCSETs cannot substitute crucial needs:
  - additionally consider social context (cannot be coded by quantitative data)
  - actions of human actors on ground and across social networks that eventually out-scale innovations.

Thank you !