Satellite-based Integrated Land and Water Use Information for an Alert Response to Drought

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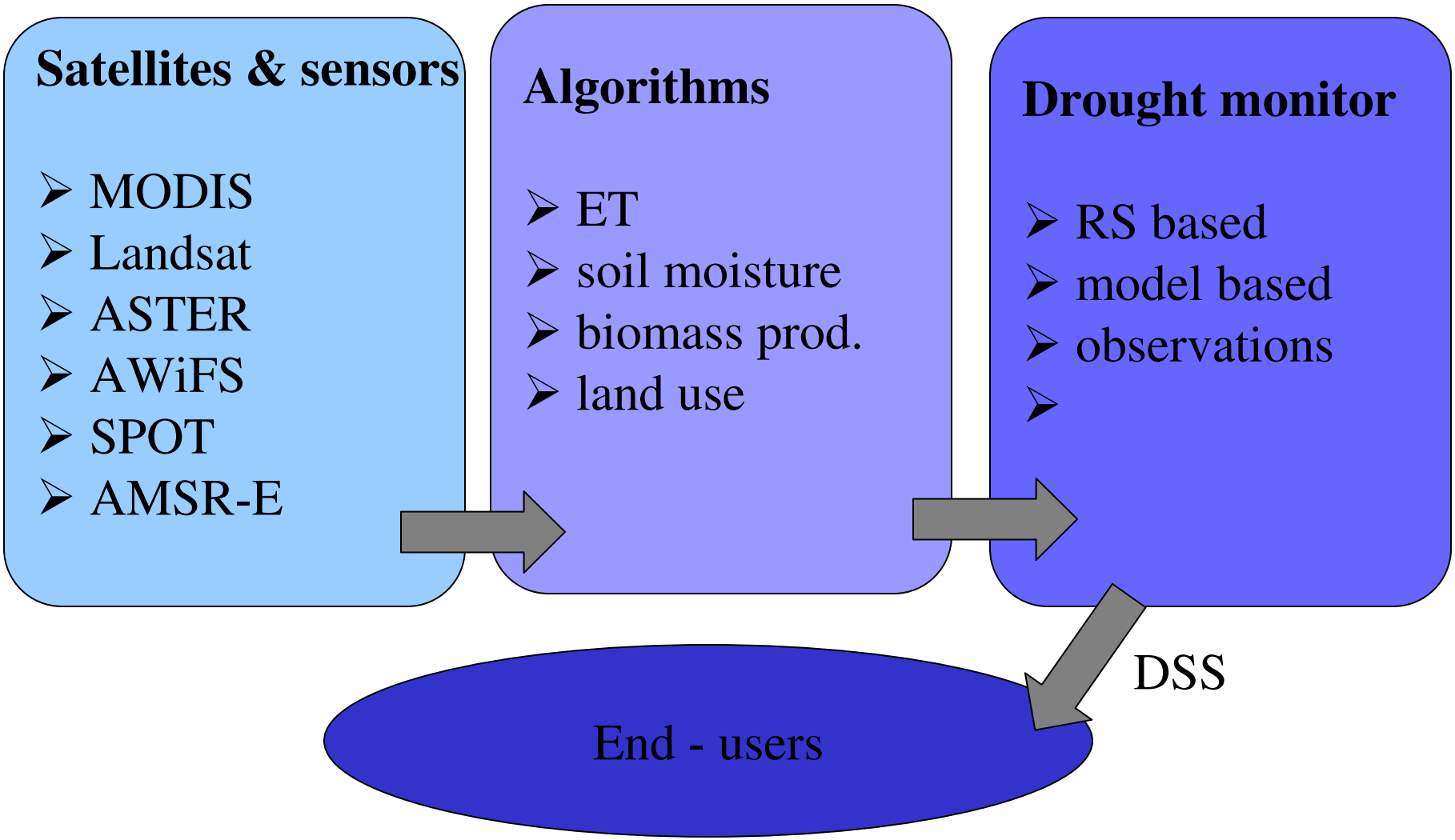
Drought Analysis and Action



Remote sensing - monitoring and evaluating drought indicators spatially

mapping drought anomalies

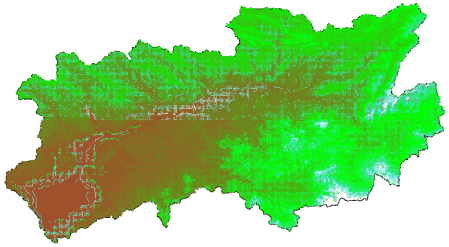
- Green ground cover (NDVI)
- Cloud cover
- Surface temperature
- Soil moisture in top layer

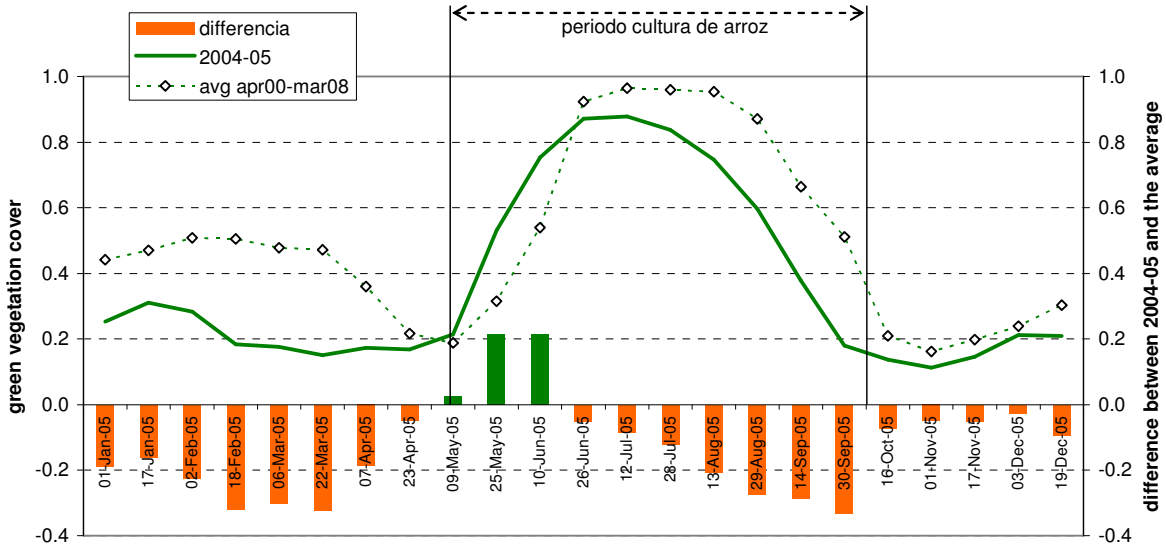
Advantages: easy to derive, to visualize and to explain

Disadvantages: Provides qualitative information only

Representación espacial, modelización y predicciones de periodos de sequía con la teledetección

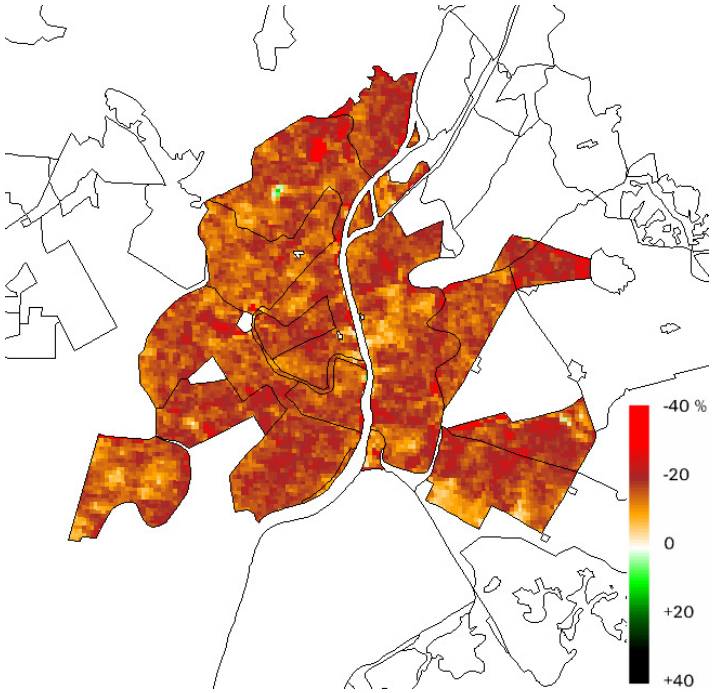
Teledetección – seguimiento y evaluación de los indicadores de sequía espacialmente





Perfil temporal del NDVI (Octubre 2004 – Septiembre 2005)

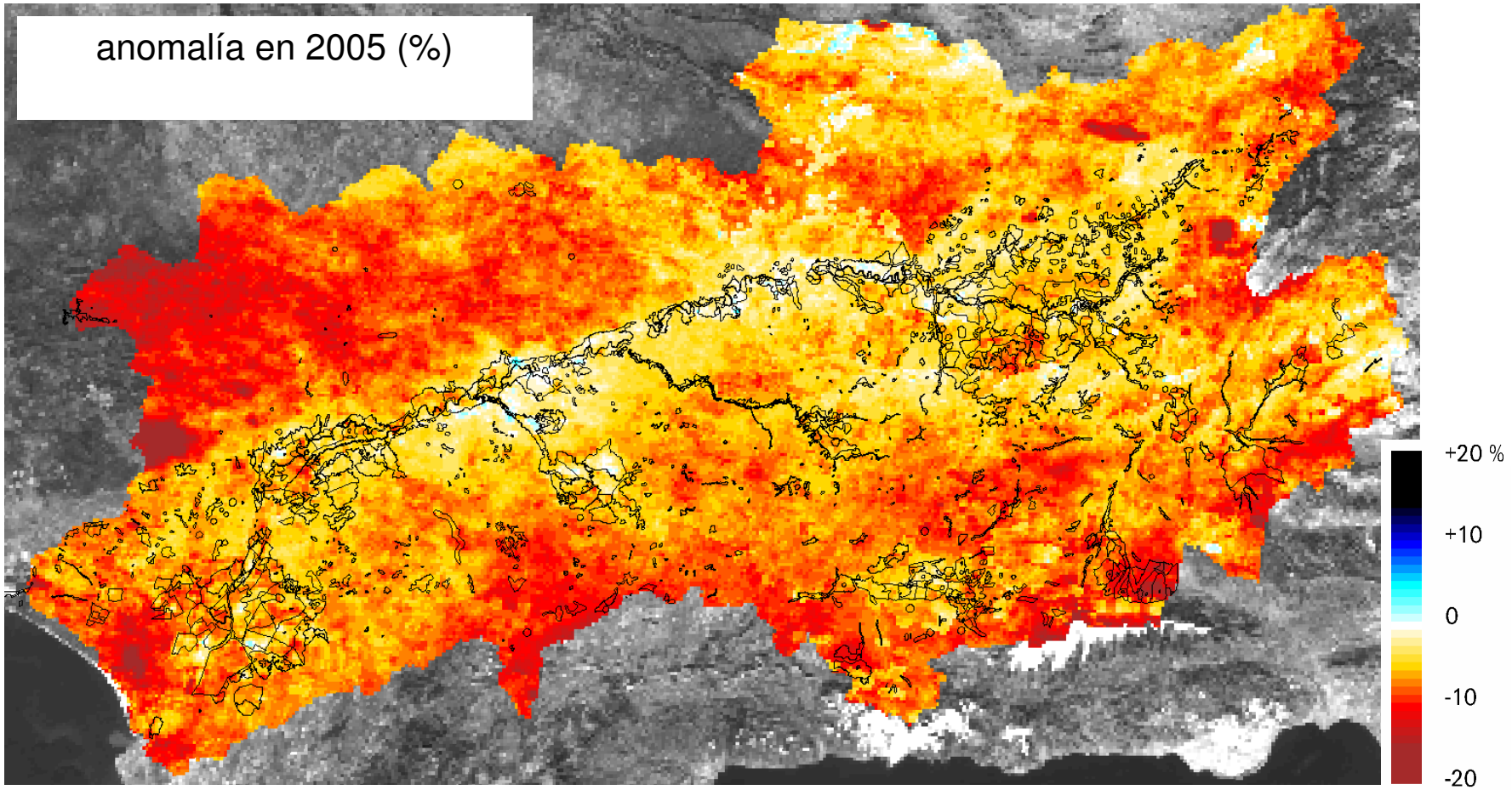
arrozales Isla Mayor



Anomalías acumuladas de 2005
en comparacion con la media de 2000-2008

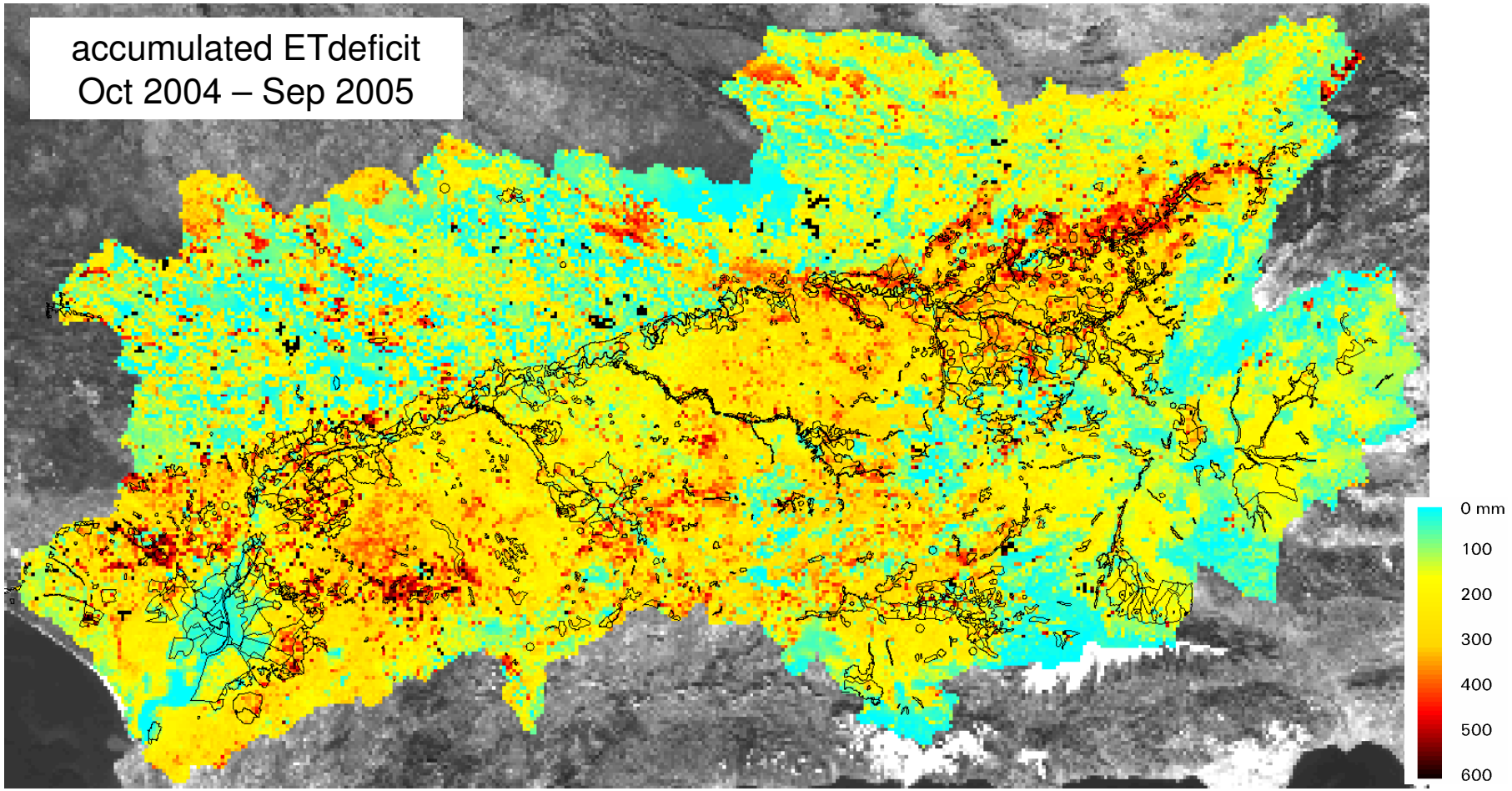
Representación espacial, modelización y predicciones de periodos de sequía con la teledetección

Teledetección – seguimiento y evaluación de los indicadores de sequía espacialmente

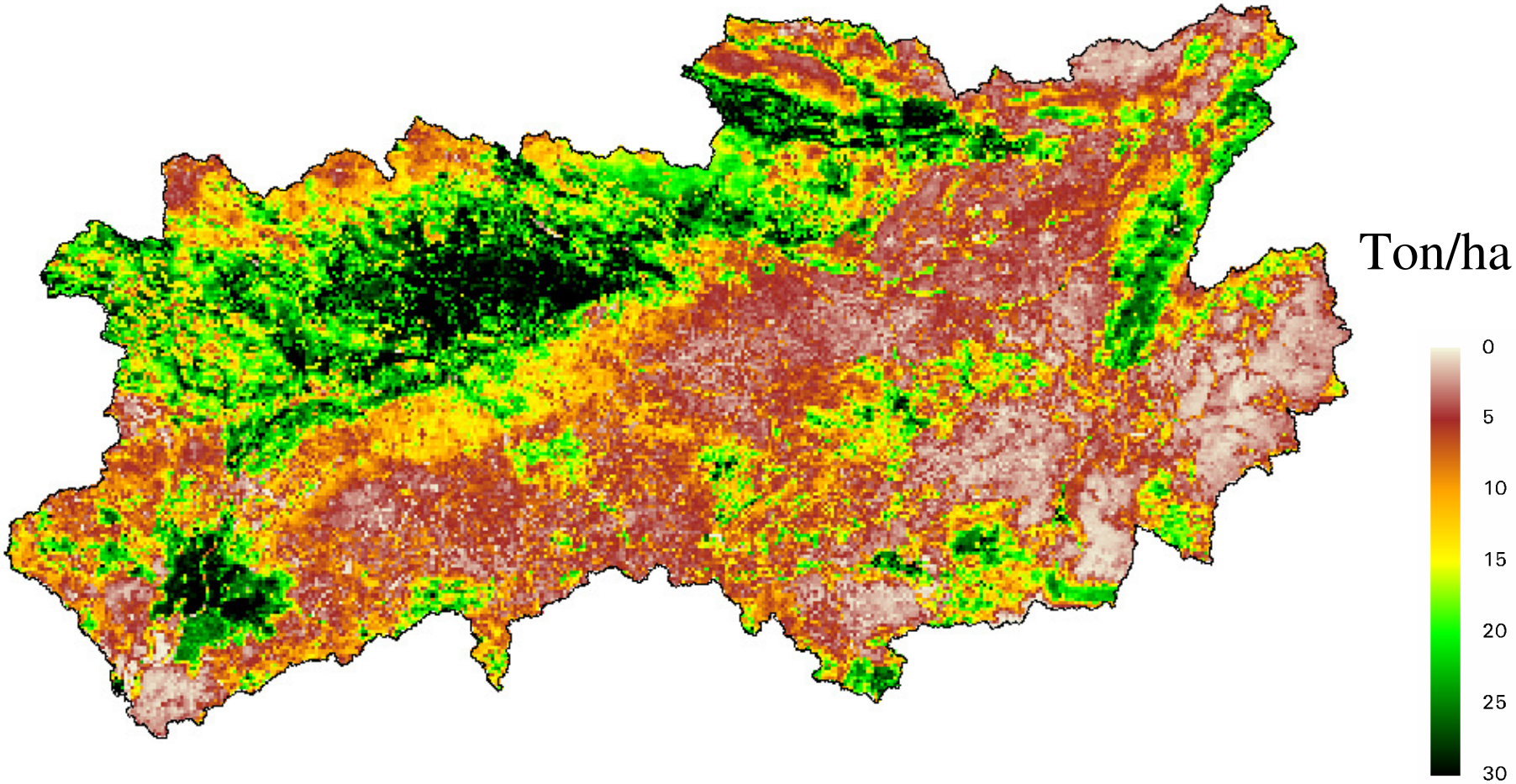


Representación espacial, modelización y predicciones de periodos de sequía con la teledetección

Teledetección – seguimiento y control de la evolucion espacial de los indicadores de sequía

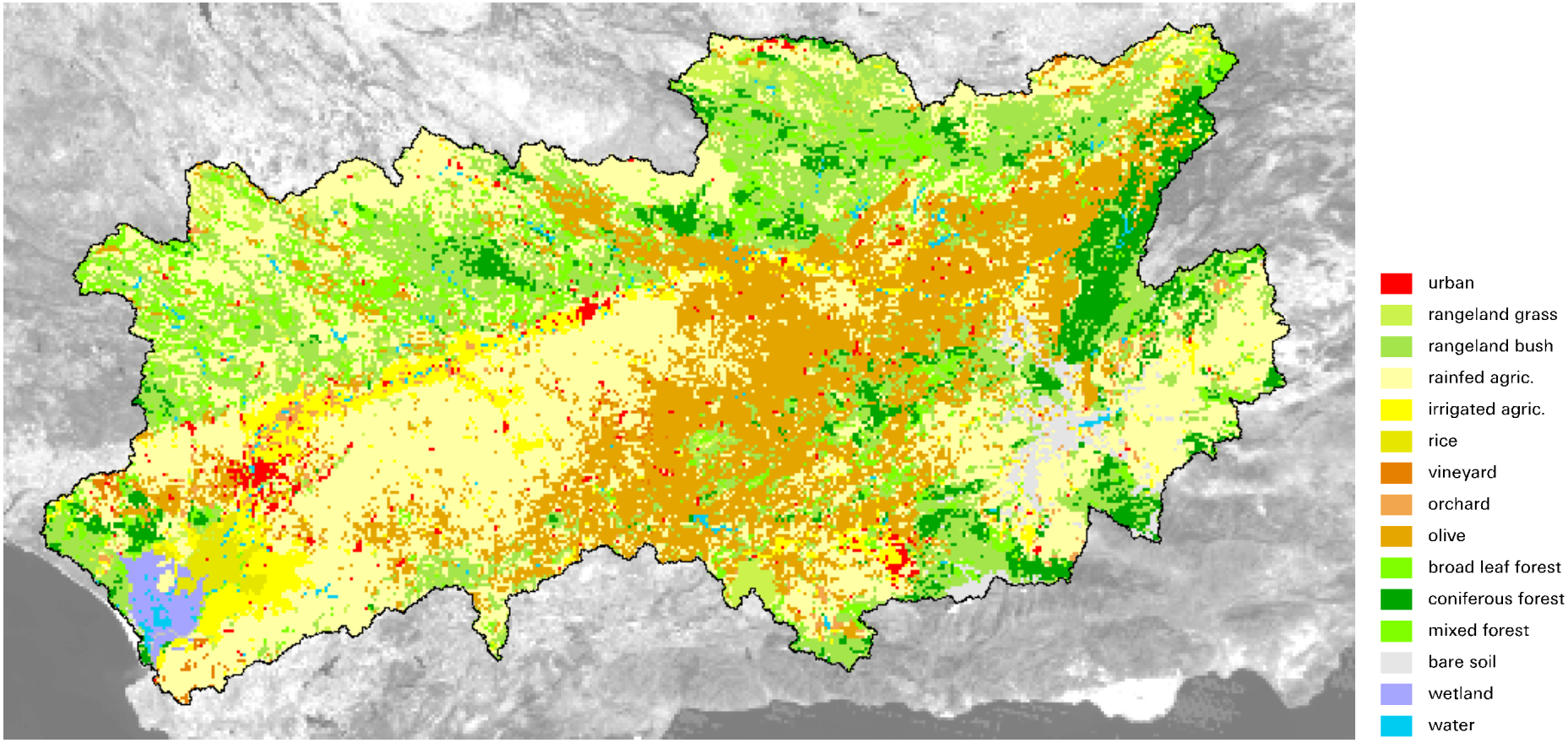


Carte de la Production de Biomasse en 2005



Land Use Map Quadalquivir

Corine



Integrated Land and Water Use 2005

	surface (ha)	ET_{act} (mm/yr)	ET_{act} (Mm^3/year)	T_{act}/T_{pot} (-)	biomass (kg/ha/yr))	Rainfall (mm/yr)
continuous urban	659,00	220	145	0.46	7,733	246
discontineous urban	2,500	211	5	0.44	8,222	239
rangeland grass	143,000	485	694	0.74	15,196	246
rangeland bush	1,026,200	342	3512	0.74	20,803	279
agriculture	2,009,800	375	7541	0.68	12,714	253
irr. agr.	255,500	655	1672	0.76	17,008	255
rice	40,400	975	394	0.91	22,322	244
vineyard	21,600	213	46	0.49	8,863	284
orchard	48,000	397	191	0.69	16,245	267
olive	1,187,600	244	2903	0.67	13,015	239
broad leaf forest	315,800	249	787	0.76	26,679	266
coniferous forest	361,800	252	913	0.77	25,142	301
mixed forest	49,200	202	99	0.74	22,357	290
bare soil	86,200	398	343	0.71	5,527	323
wetland	44,100	480	212	0.65	5,255	252
water	41,500	807	335	0.00	16	253

Allocation of surface water resources

Sector	Priority
- Domestic	1
- Energy	1
- Industry	2
- Endangered species	2
- Navigation	3
- Irrigation	4
- Wetlands and parcs	5
- Recreation and tourism	5

Urban Water Users

Urban

	Inflow (MCM/yr)	Consumption (MCM/yr)	Outflow (MCM/yr)
Rainfall	162.1		
Diversion	44.4		
Transpiration, sweating		3.0	
ET		145.0	
Discharge			58.5
TOTAL	206.5	148.0	58.5

Industrial

	Input (MCM/yr)	Consumption (MCM/yr)	Outflow (MCM/yr)
Rainfall	6.0		
Diversion	8.4		
ET		5.3	
Discharge			9.1
TOTAL	14.4	5.3	9.1

4,242,773 inhabitants Quadalqivier basin

Energy

Hydropower and thermal plants

	Input (MCM/yr)	Consumption (MCM/yr)	Output (MCM/yr)
Diversion Hydropower	965.3		
Diversion Thermal plant	50.0		
ET		334.9	
Discharge			680.4
TOTAL	1015.3	334.9	680.4

Irrigation

Irrigation

	Input (MCM/yr)	Consumption (MCM/yr)	Output (MCM/yr)
Rainfall	750.1		
Diversion	2113.2		
ET irrigated land		1474.8	
ET rice		393.9	
Discharge			
TOTAL	2863.3	1868.7	994.6

Environment

Wetlands and parcs

	Input (MCM/yr)	Consumption (MCM/yr)	Output (MCM/yr)
Rainfall	111.1		
Diversion	178.1		
ET irrigated land		211.8	
Discharge			77.4
TOTAL	289.2	211.8	77.4

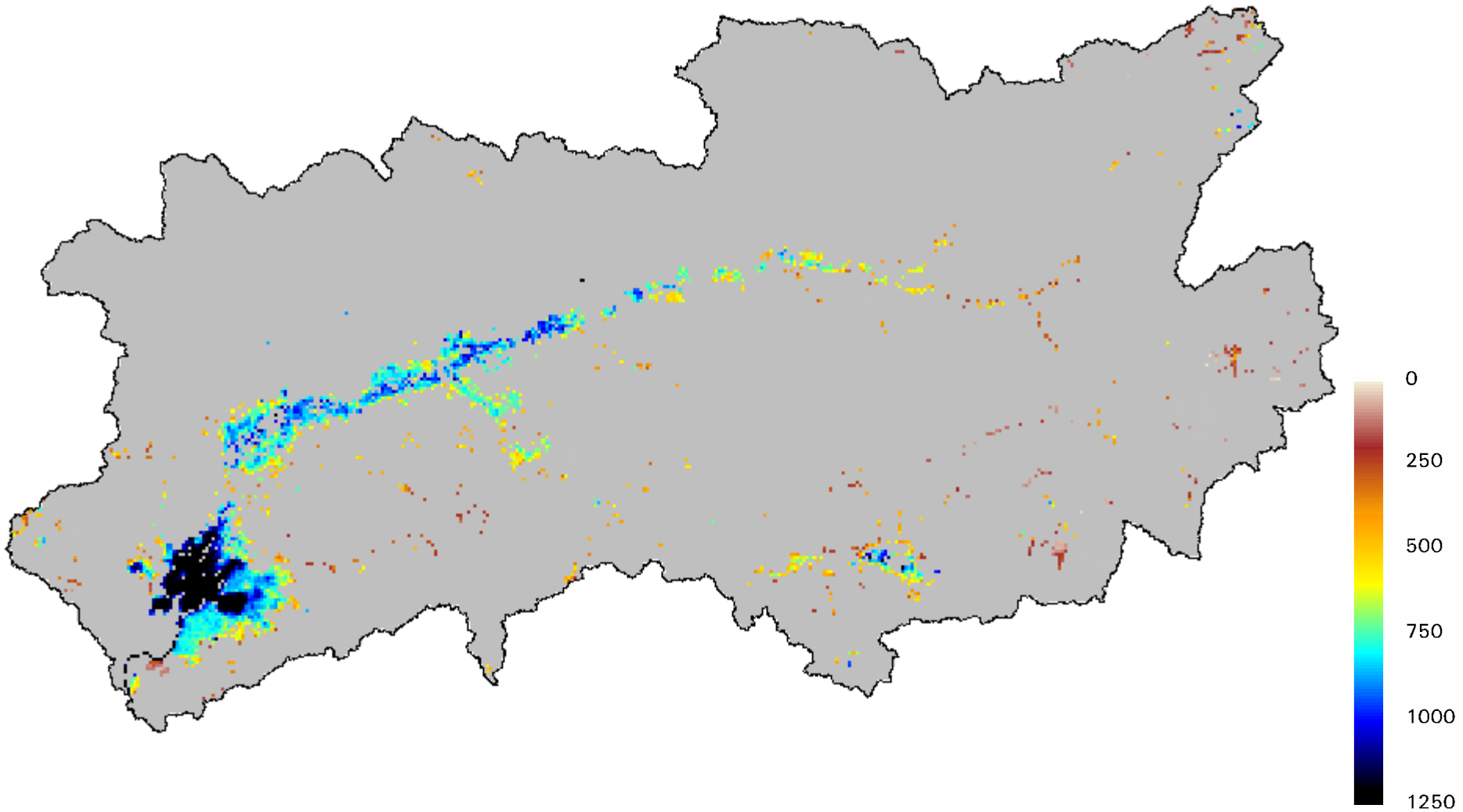
	Diversion (MCM/yr)	Consumption (MCM/yr)	Water shortage (MCM/yr)
Domestic	44.4	148.0	**6.9**
Industry	8.4	5.3	**0.3**
Hydropower	965.3	318.4	**213.3**
Thermal plants	50.0	16.5	**11.1**
Irrigation	1500	1868.7	365.3
Wetland and parcs	178.1	211.8	73.0

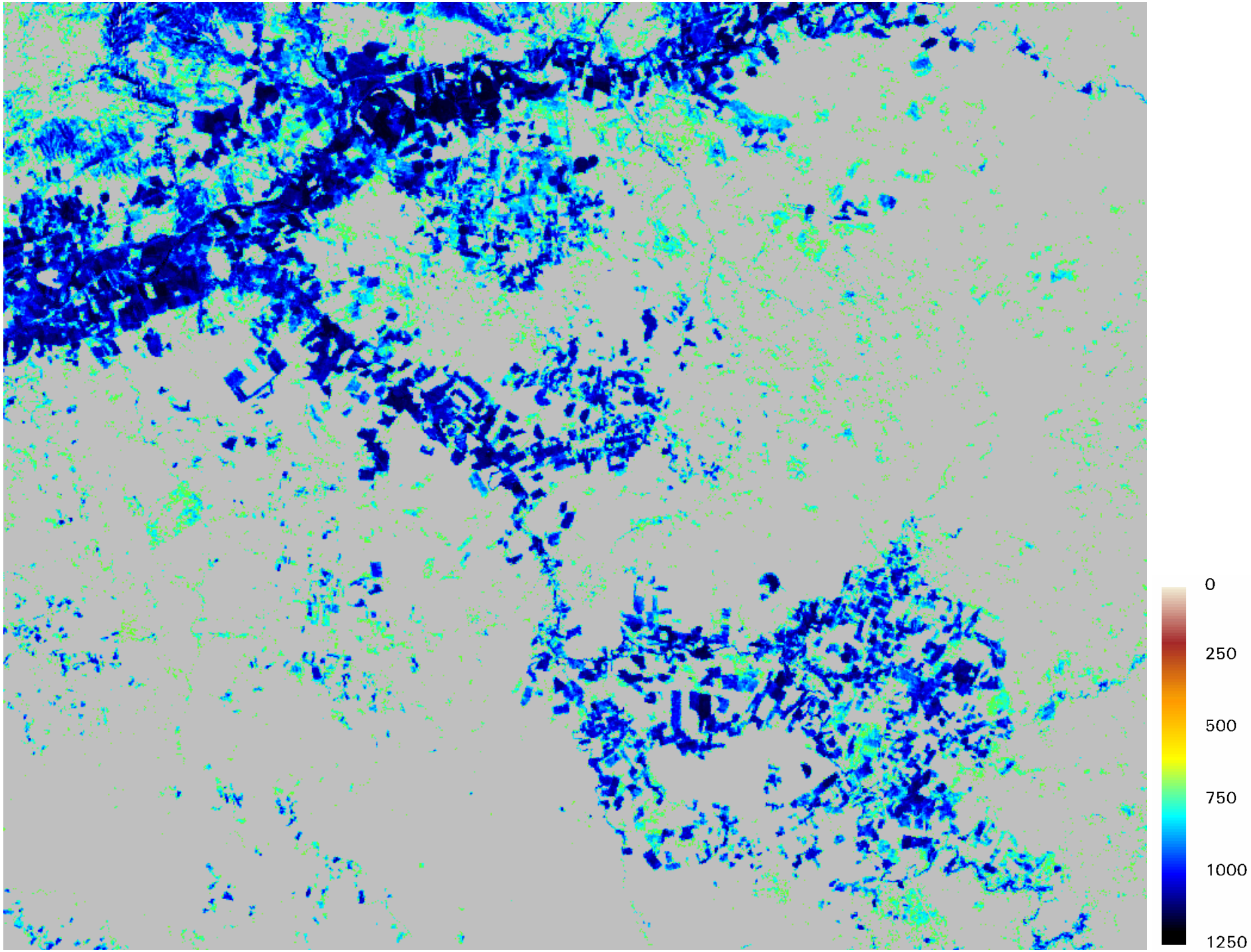
Re-allocate 6.9+0.3+213.3+11.1=231.6 MCM/yr

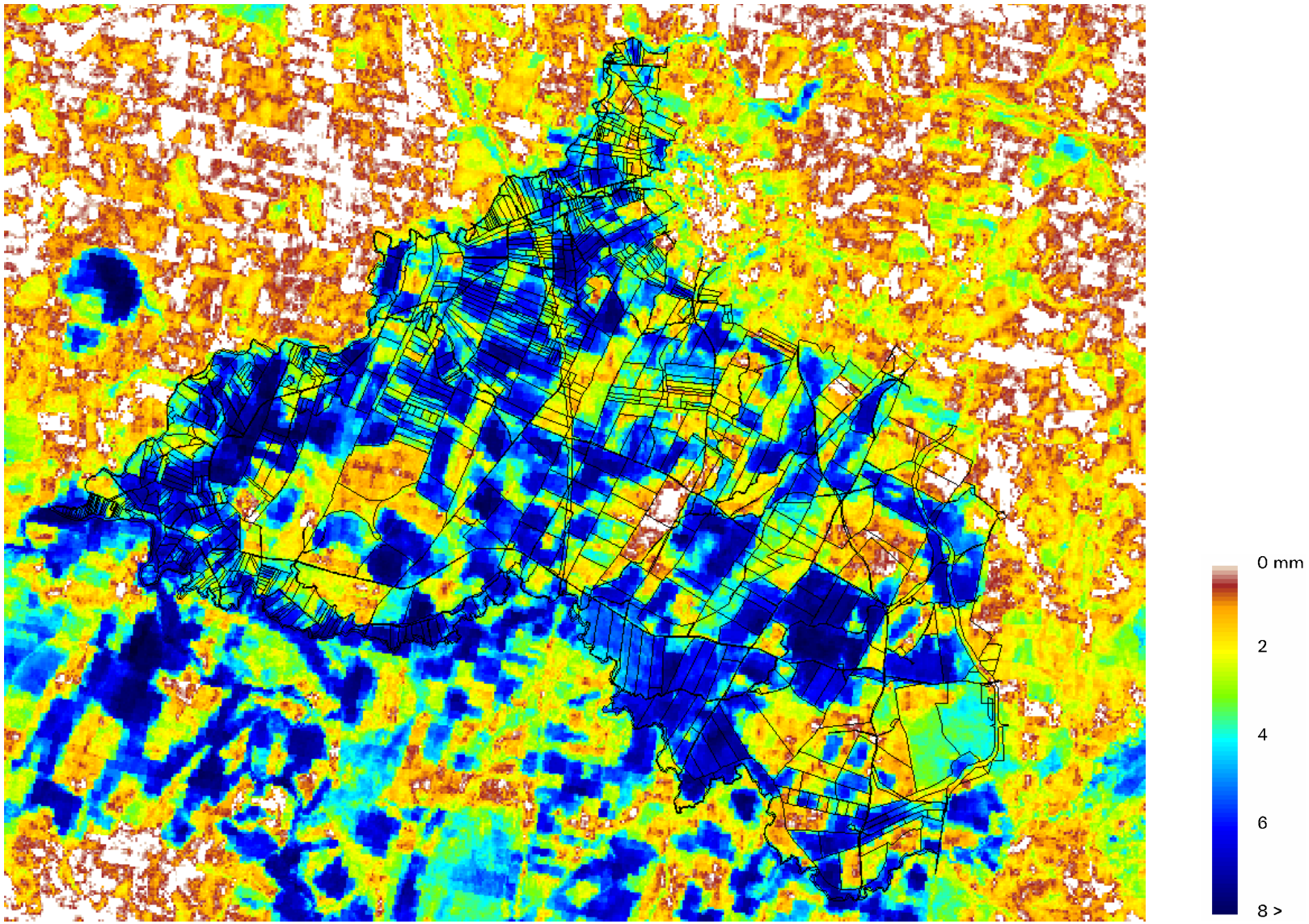
Solution: save 231.6 MCM/yr in irrigation:

1) Fallow 23,754 ha (total 295,900 ha)
2) Impose 12% stress on all irrigated crops

Consumptive use in irrigation

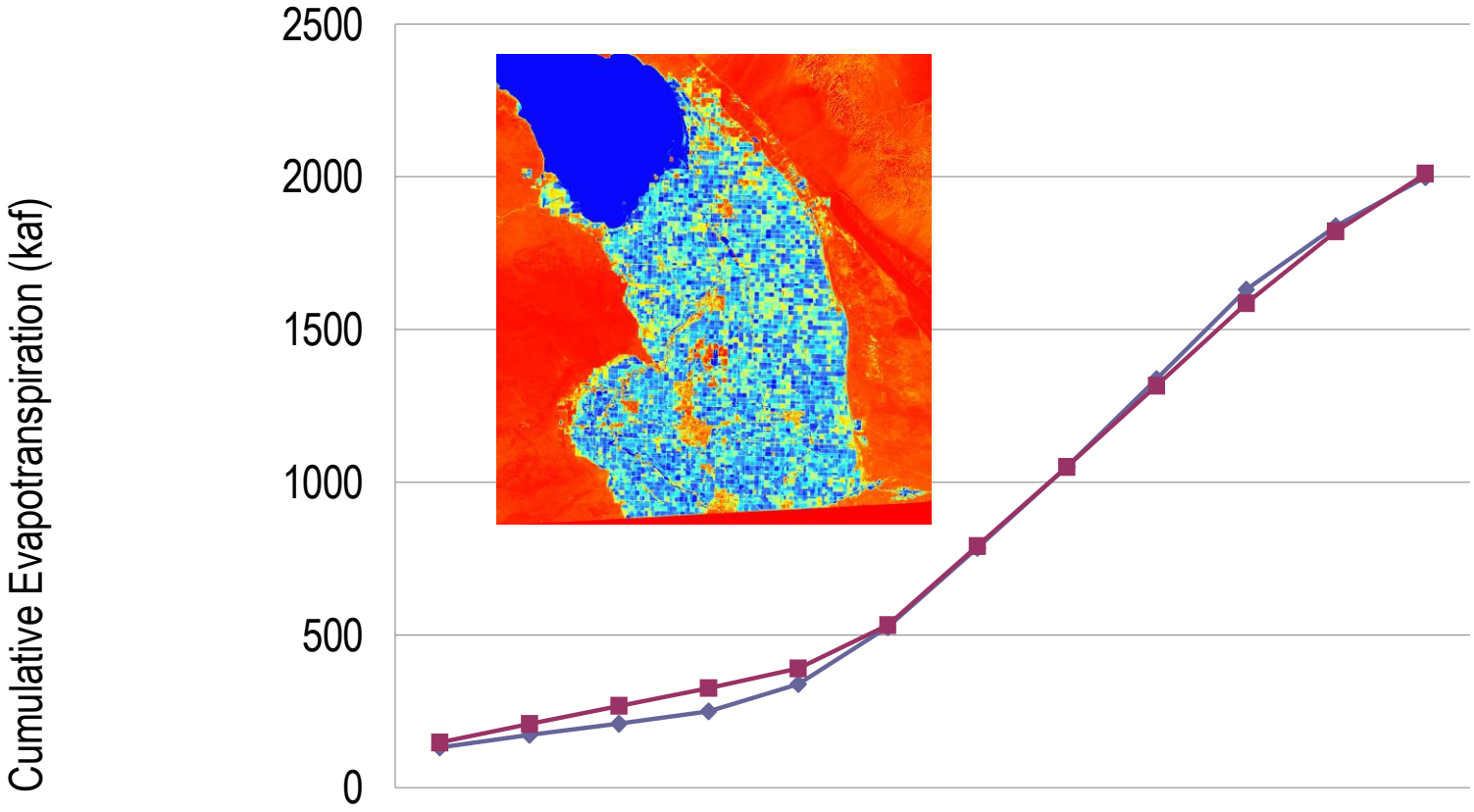



0
250
500
750
1000
1250



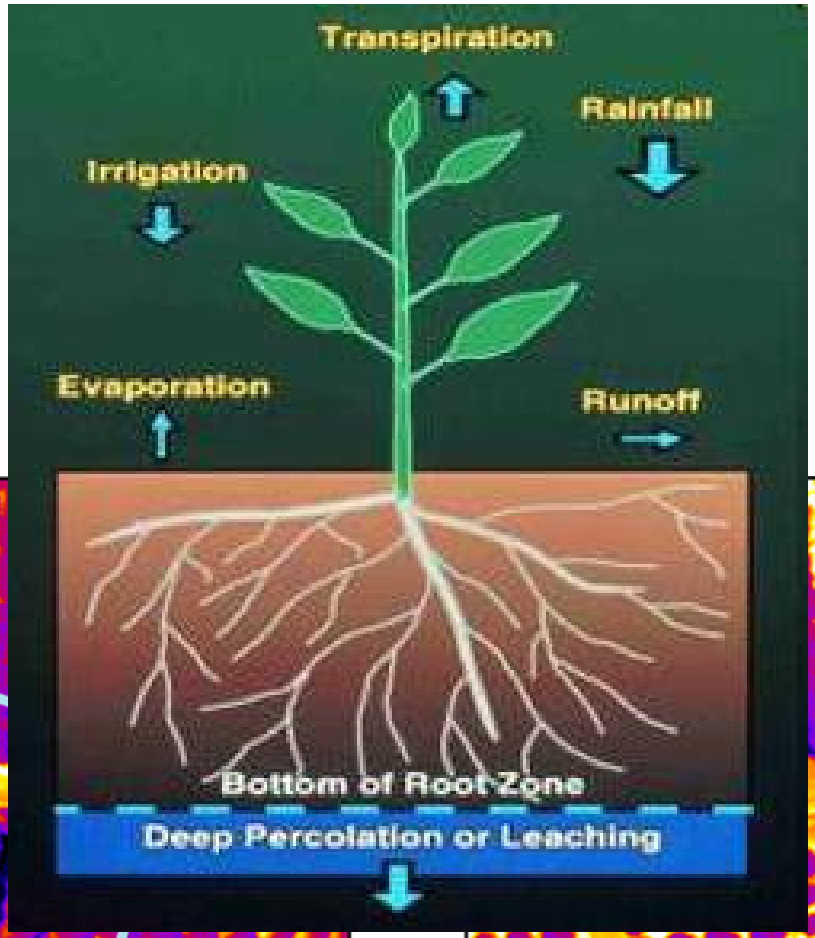
Genil-Cabra irrigation system ET July 11, 2005

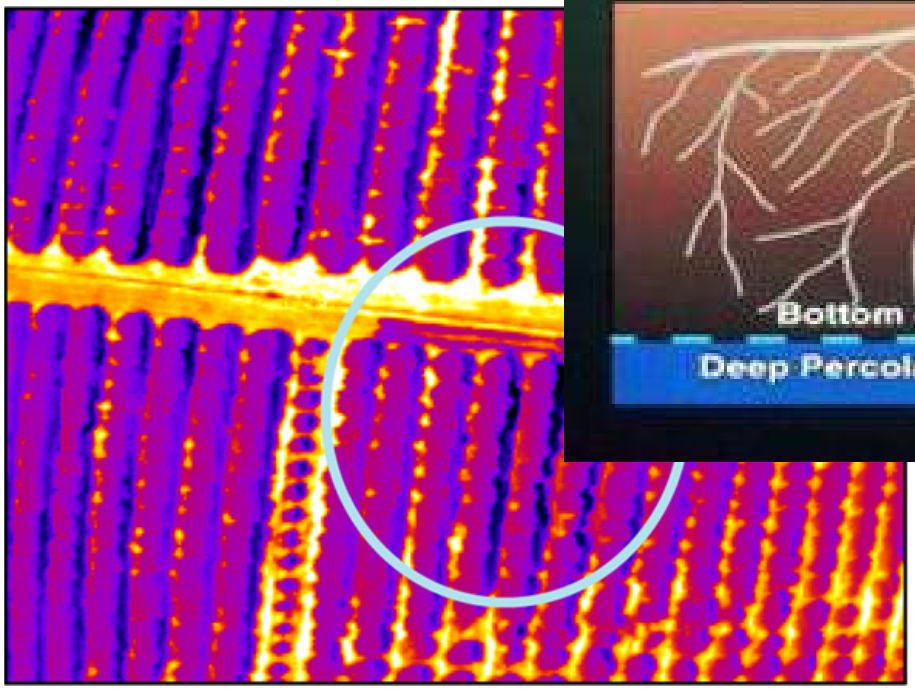
Validation Imperial Valley

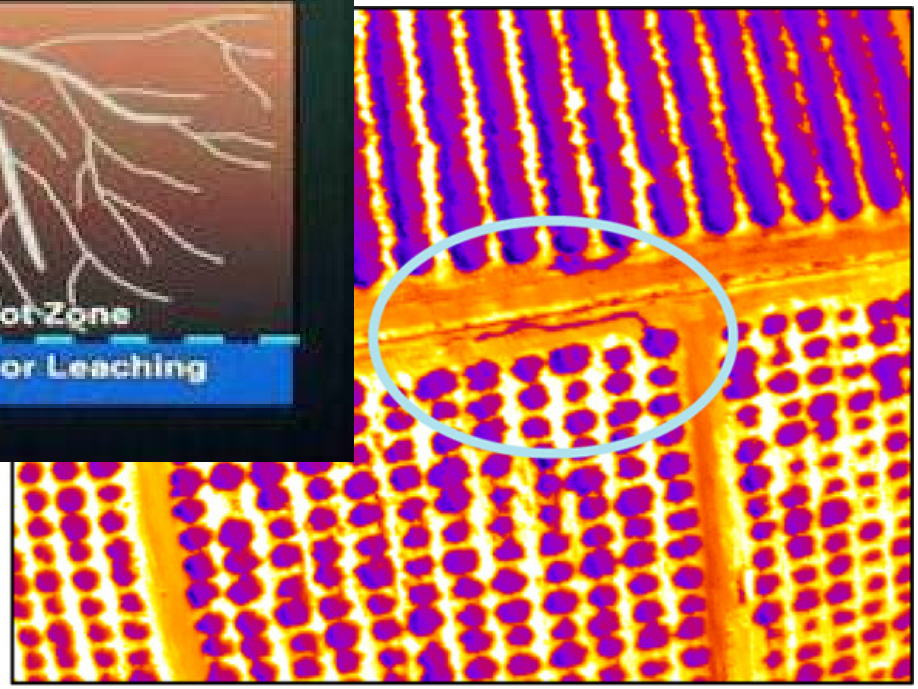


	Oct-97	Nov-97	Dec-97	Jan-98	Feb-98	Mar-98	Apr-98	May-98	Jun-98	Jul-98	Aug-98	Sep-98
Water Balance	132	173	209	250	340	526	785	1051	1337	1631	1838	1999
SEBAL	148	209	268	326	391	532	791	1049	1316	1586	1821	2010

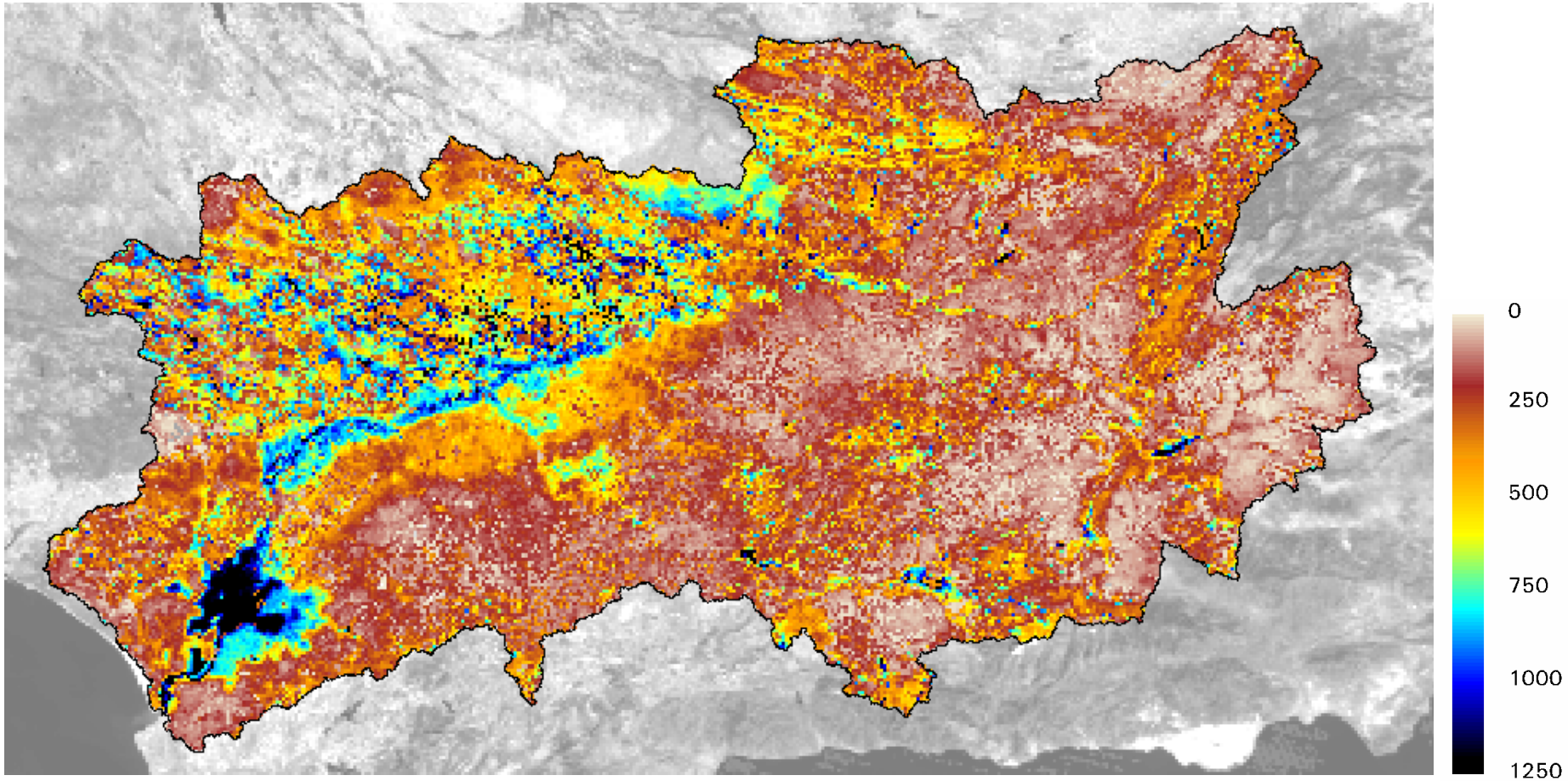
ET from TIR or from soil moisture







ET from MODIS (TIR)



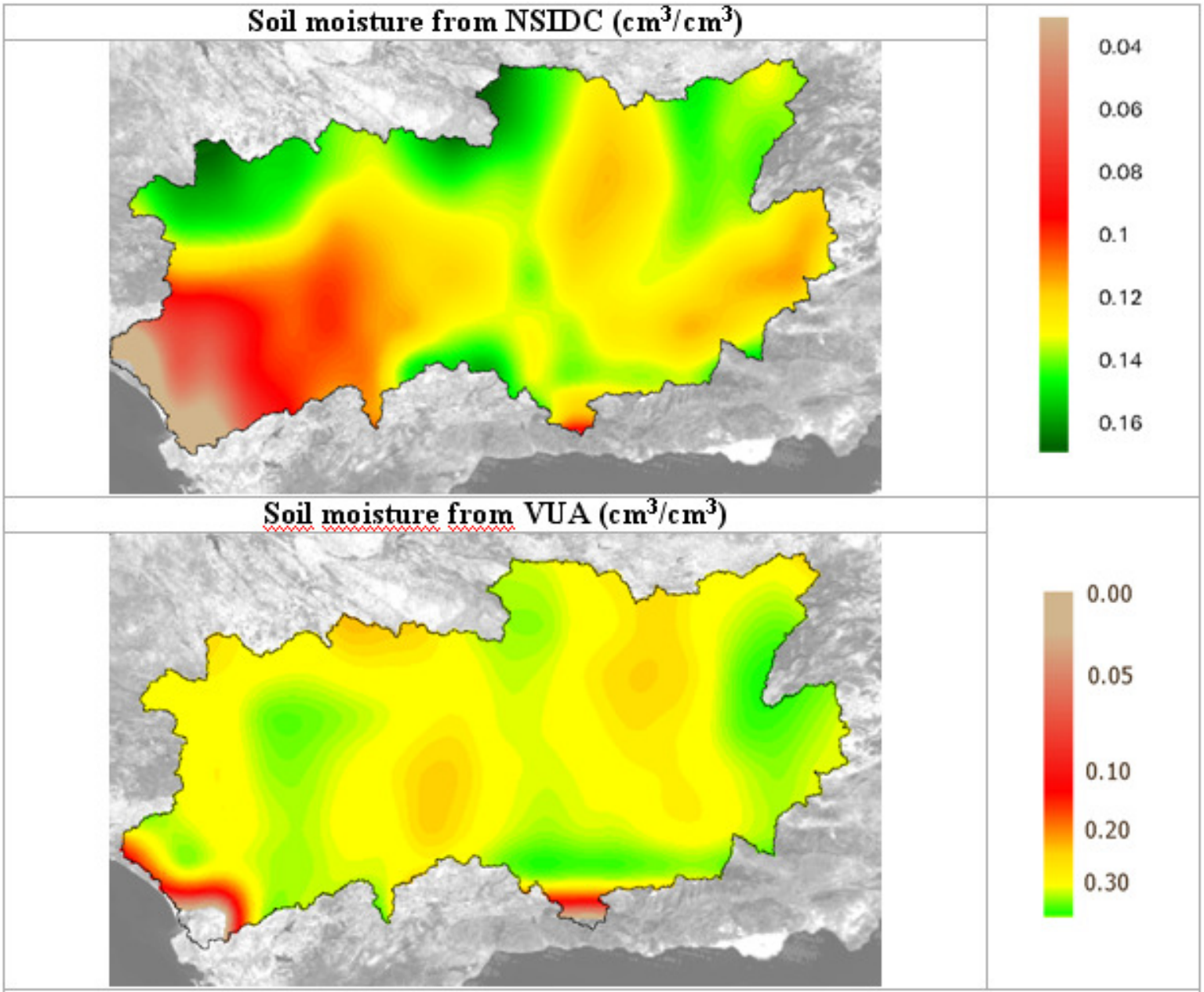
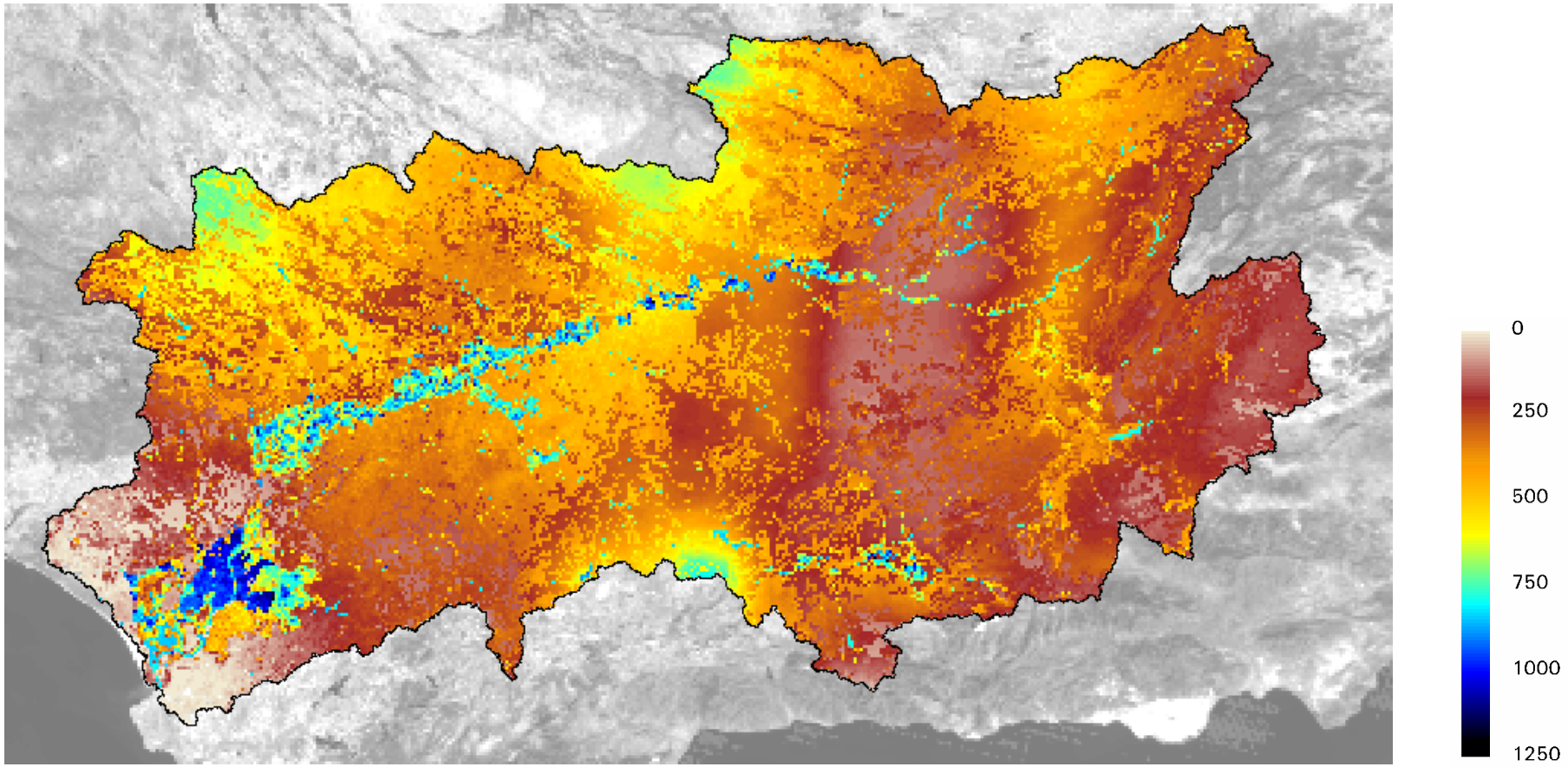
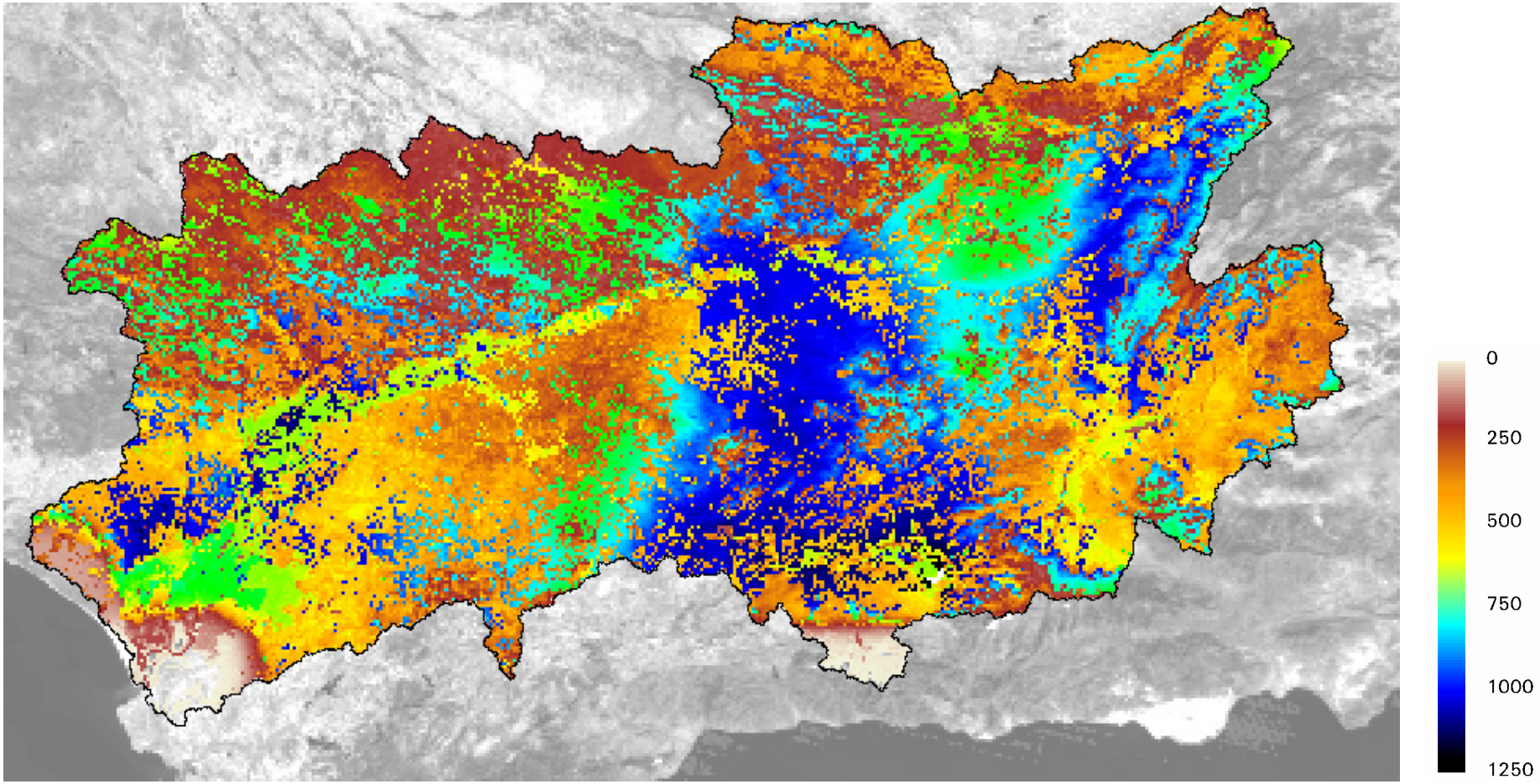


Figure 11. Annual average soil moisture from AMSR-E with two extraction methods : the NSDIC method (A) and the VUA method (B)

ET from soil moisture NSDIC



ET from soil moisture NASA / VU



Limitations of RS data

- water levels in rivers and reservoirs
- groundwater levels
- natural flows
- diverted flows
- clouds
- no scenario's

solution: couple to hydrological models

Missing sensors for drought

- high resolution TIR (30 to 60 m)
- high resolution soil moisture (30 to 60 m)
- 3 day intervals
- minimum coverage 500 km
- low costs

Conclusions

- Water allocations options are minimal
- Consumptive use of hydropower, irrigated areas, wetlands and urban sprawls from RS
- Couple RS to hydrological models
- High frequency - high resolution TIR or soil moisture imagery (both provide ET)
- Drought management is more than water level monitoring (supply and demand)
- Drought response requires proper institutions