



LAND APPLICATION SYSTEMS AS ENVIRONMENTALLY FRIENDLY WASTEWATER AND REUSE SYSTEMS

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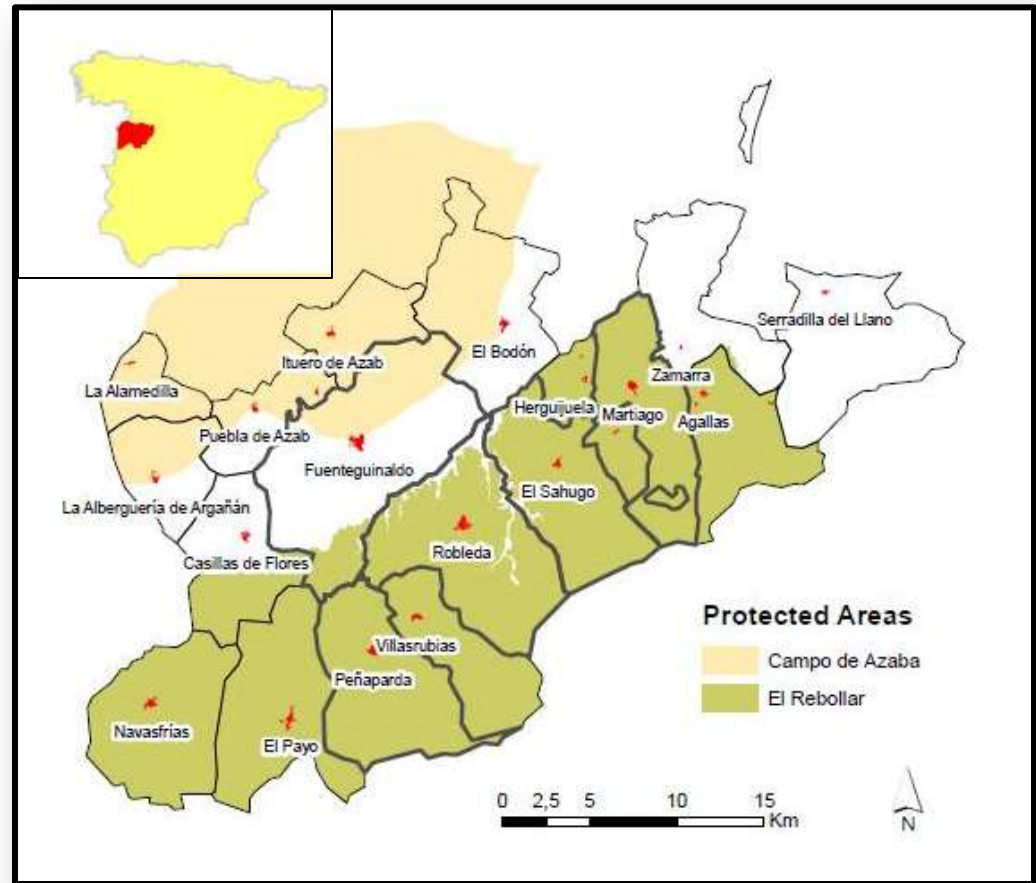


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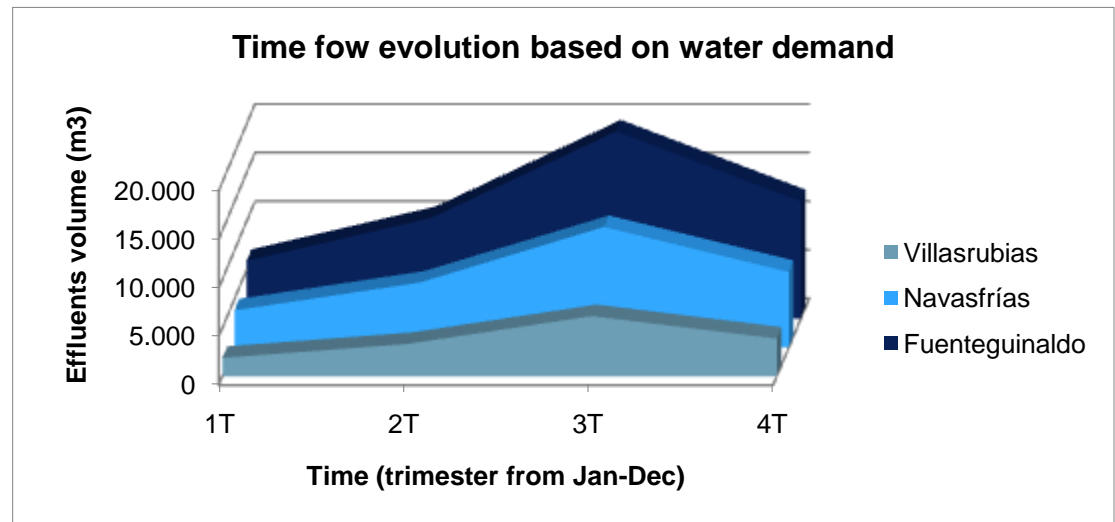
Study Area

- *Location:* SW Salamanca Province, Sierra de Gata.
- *Area:* 35.000 Ha.
- *Population:* 5 municipalities, 2.346 inhabitants (INE, 2009).
- *Hidrology:* River Duero Basin, Águeda River basin.
- *Protected Areas:* “**El Rebollar**” and “**Campo de Azaba**” SCI (Natura 2000 Network).
- P_{mean} : 1300mm, T_{mean} : 8,5 °C



Issues

- Small towns (Fuenteguinaldo: 803 inhab., El Sahugo: 262 inhab.) Population density: 7 hab/km²
- High flow increase during summertime
- Need for an effective and economically feasible treatment system.
- Low tax income budget
- Management and maintenance conventional sewage costs unaffordable
- Minimization of impacts, due to the protected areas where are located.



Land Application Systems like an extensive system

- **Land Application Systems** with forest mass (LST) consists of a plot of land, determined by the influent to treat, where arboreal vegetation is planted and irrigated with wastewater.
- Treatment by Soil-Plant-Biota
- The wastewater evaporates partially, so the remainder part is used by the tree roots and leaked through the ground
- Local climate conditions are the main design variable
- Environmental and geological properties are fundamental for a good treatment



Spanish and european law

Regulation 91/271 of the European Community legislation: populations with fewer than 2,000 inhabitants must treat properly their wastewaters before dumping them into the receiving environment

RD 1620/2007 on wastewater reuse establishes the quality limits that regenerated water must fulfil for its reuse.

LST \longrightarrow silviculture
 \longrightarrow Indirect aquifer recharge

USO DEL AGUA PREVISTO	VALOR MÁXIMO ADMISIBLE (VMA)				
	NEMATODOS INTESTINALES	ESCHERICHIA COLI	SÓLIDOS EN SUSPENSIÓN	TURBIDEZ	OTROS CRITERIOS
5.- USOS AMBIENTALES					
CALIDAD 5.1 a) Recarga de acuíferos por percolación localizada a través del terreno.	No se fija límite	1.000 UFC/100 mL	35 mg/L	No se fija límite	N _T ¹ : 10 mg N/L NO ₃ : 25 mg NO ₃ /L Art. 257 a 259 del RD 849/1986
CALIDAD 5.2 a) Recarga de acuíferos por inyección directa.	1 huevo/10 L	0 UFC/100 mL	10 mg/L	2 UNT	
CALIDAD 5.3 a) Riego de bosques, zonas verdes y de otro tipo no accesibles al público. b) Silvicultura.	No se fija límite	No se fija límite	35 mg/L	No se fija límite	OTROS CONTAMINANTES contenidos en la autorización de vertido aguas residuales: se deberá limitar la entrada de estos contaminantes al medio ambiente. En el caso de que se trate de sustancias peligrosas deberá asegurarse el respeto de las NCAs.

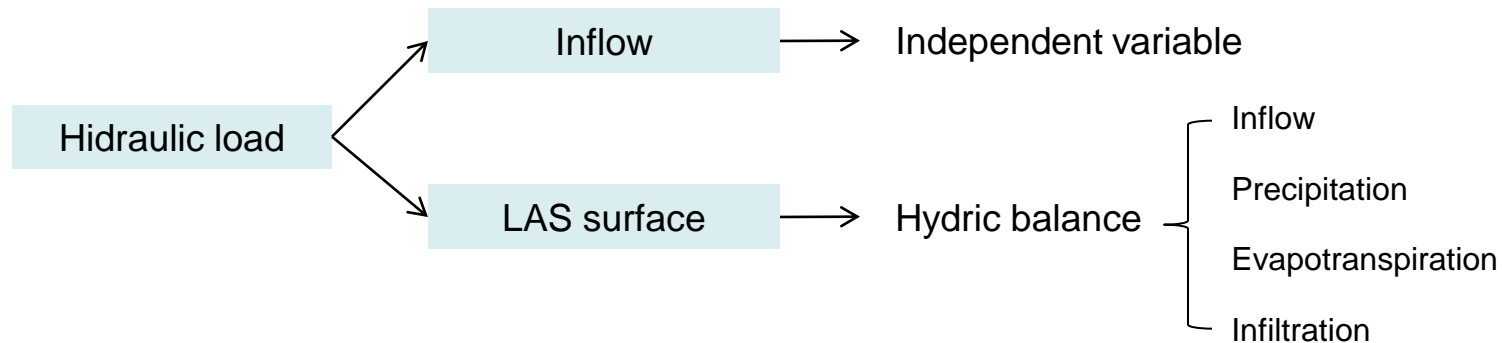
Pto 5.1 y 5.3, anex 1.A

Previous treatment must be done before apply to surface

Methodology

Technical viability

Methodology of multi-stage Land Application Systems was used (De Bustamante, *et al.* 1998; 2000; 2001; 2009)

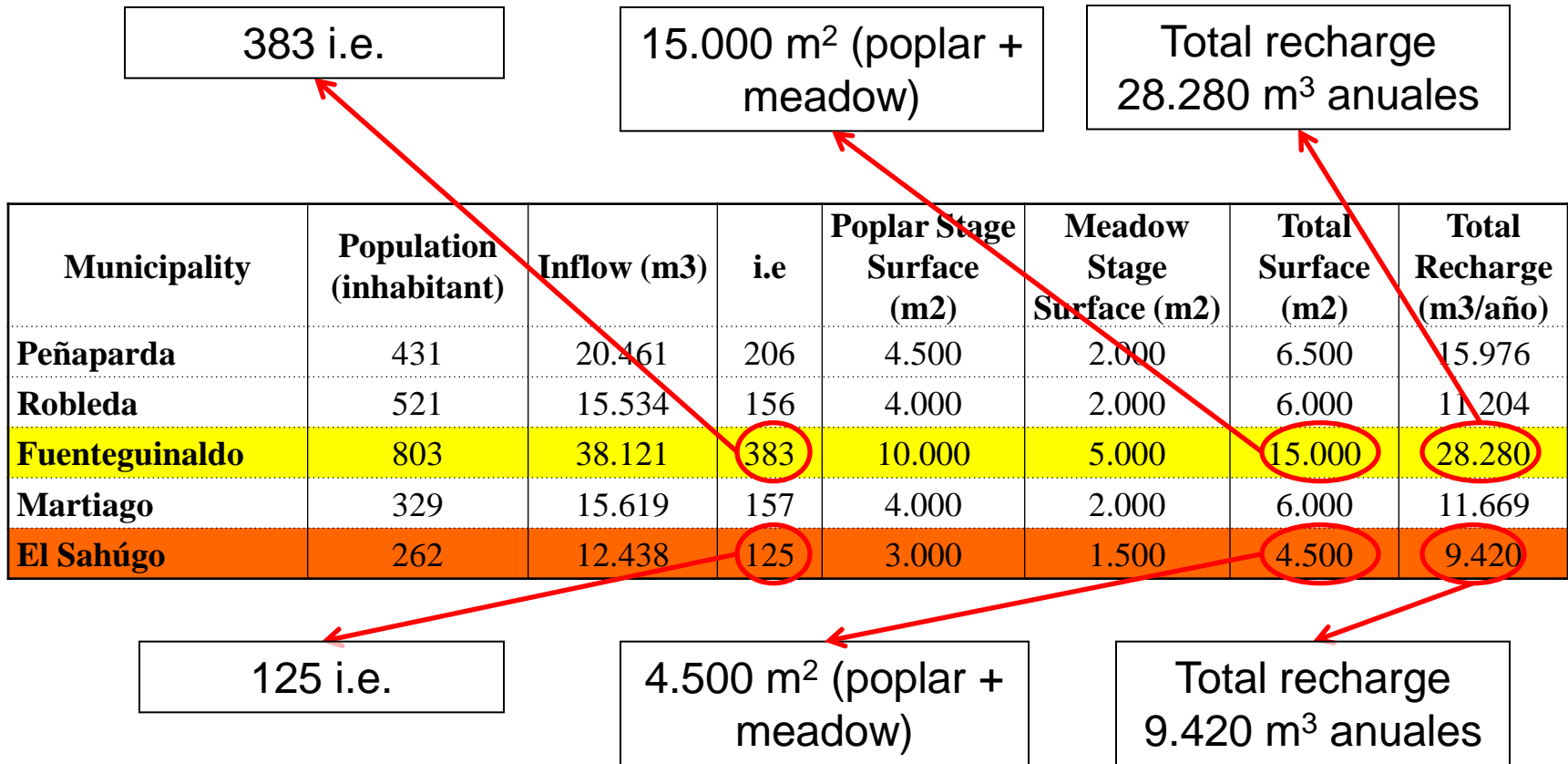


Results: technical viability

Municipality	Population (inhabitant)	Inflow (m3)	i.e	Poplar Stage Surface (m2)	Meadow Stage Surface (m2)	Total Surface (m2)	Total Recharge (m3/año)
Peñaparda	431	20.461	206	4.500	2.000	6.500	15.976
Robleda	521	15.534	156	4.000	2.000	6.000	11.204
Fuenteguinaldo	803	38.121	383	10.000	5.000	15.000	28.280
Martiago	329	15.619	157	4.000	2.000	6.000	11.669
El Sahúgo	262	12.438	125	3.000	1.500	4.500	9.420

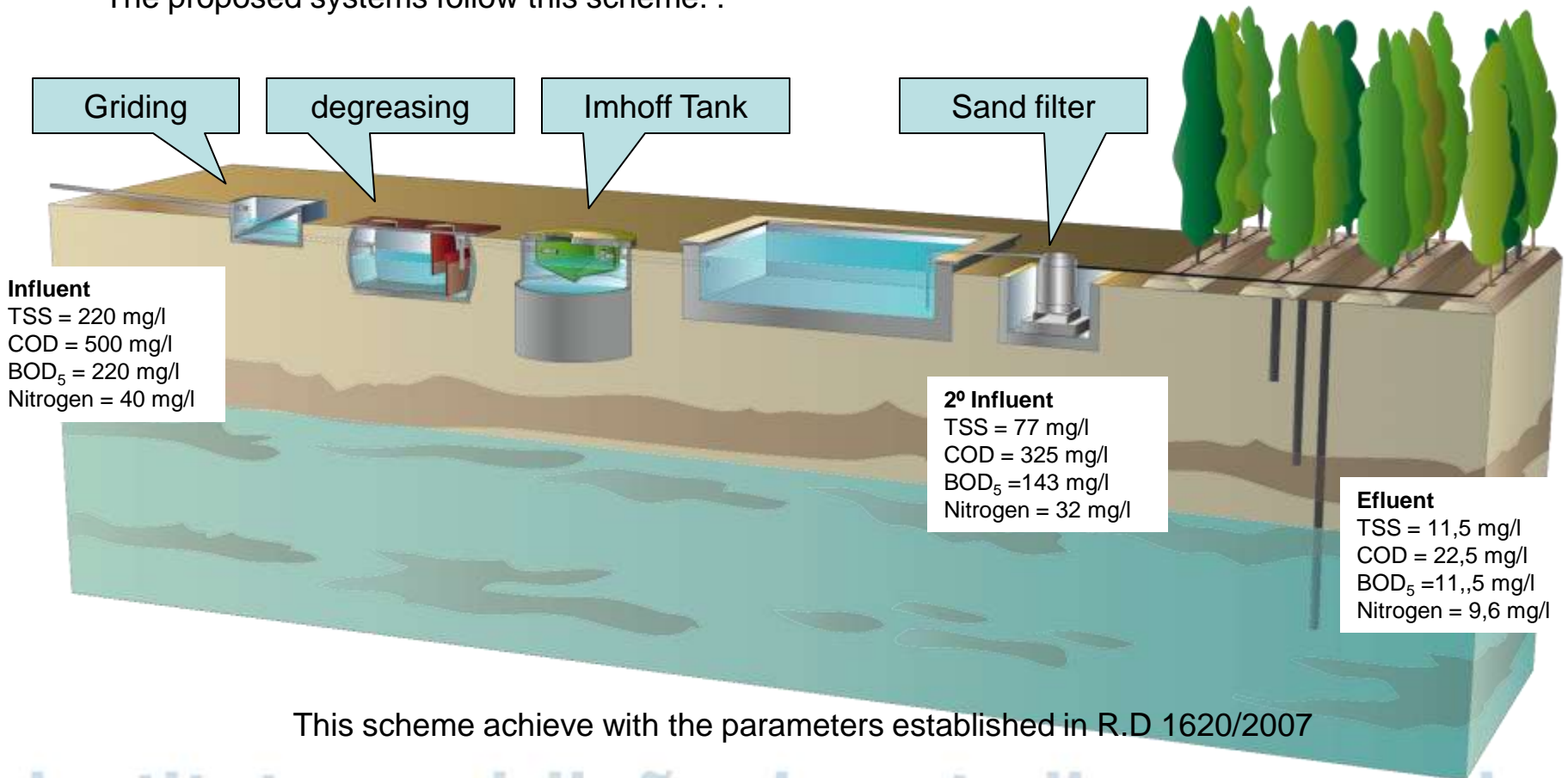
Summary of main design variables

Results: technical viability



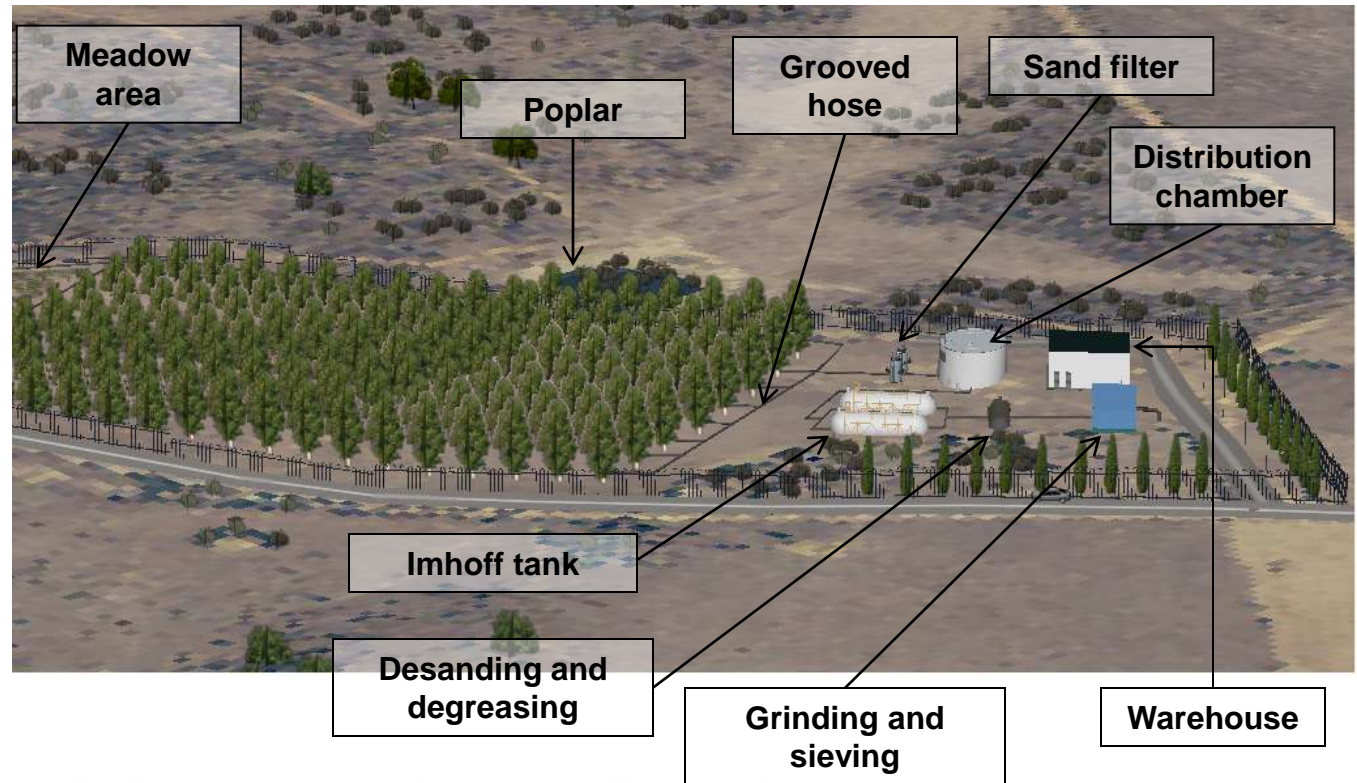
Results: technical viability

The proposed systems follow this scheme: :

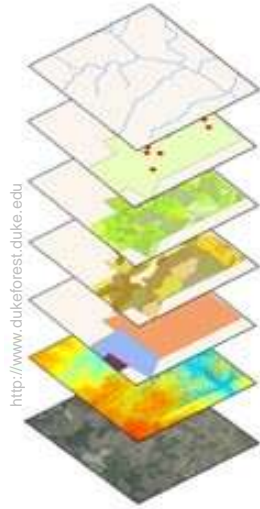


Results: technical viability

- White poplar (*Populus euroamericana*), clon I-214
- Plant grid 5x5m
- 350 feet/ha
- Street: 50 m long and 5 m wide
- Terraces
- Meadow area (grow spontaniely), 2 m wide
- Grooved hose irrigation systema



Geographical analysis



- ✓ **LST requirements**
- ✓ **Economic issues**
- ✓ **Environmental issues**

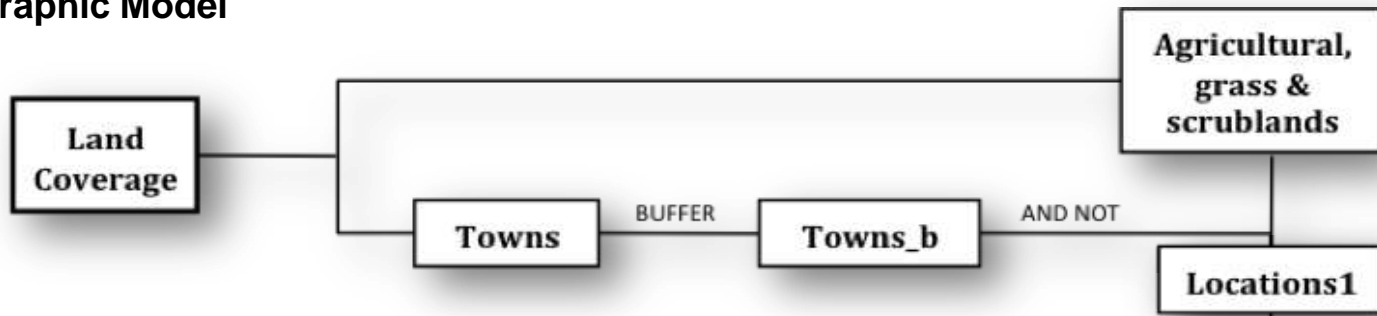
Geographical analysis

Cartographic Model

Land
Coverage

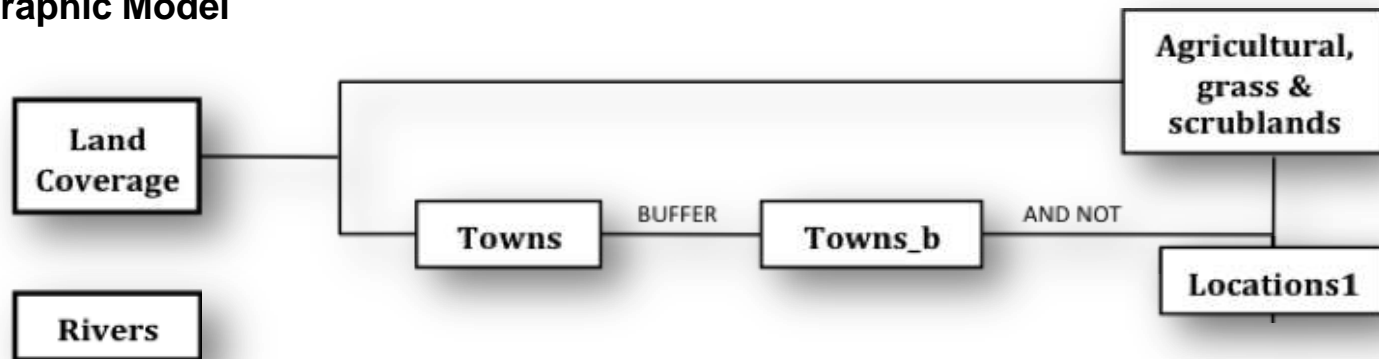
Geographical analysis

Cartographic Model



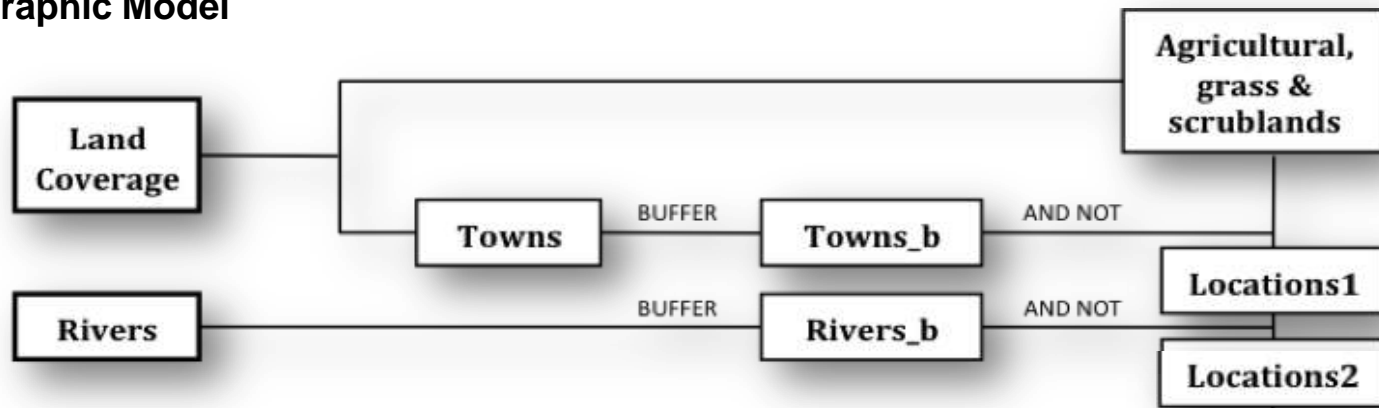
Geographical analysis

Cartographic Model



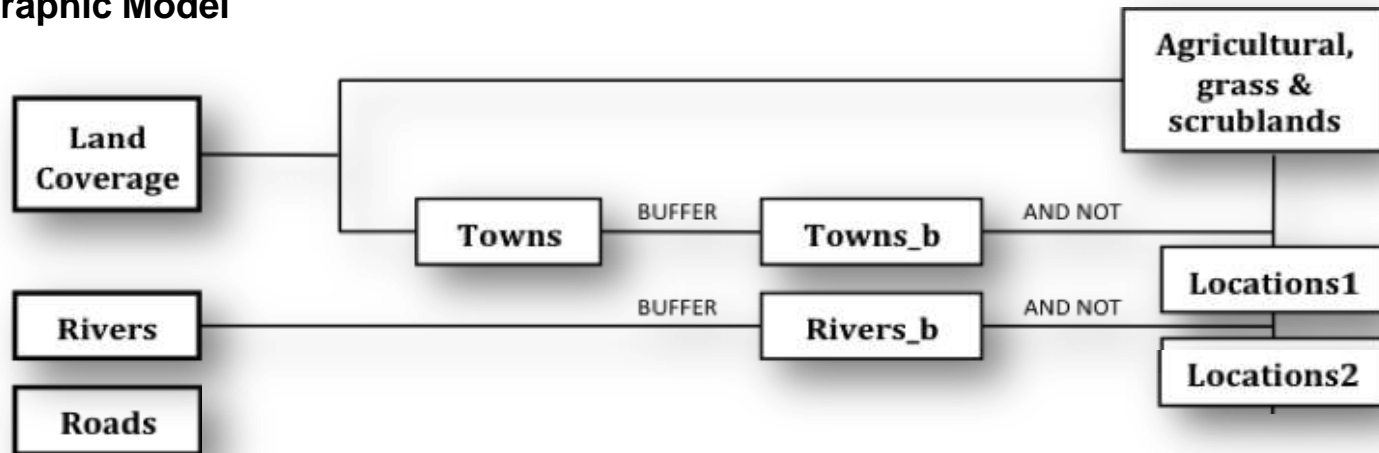
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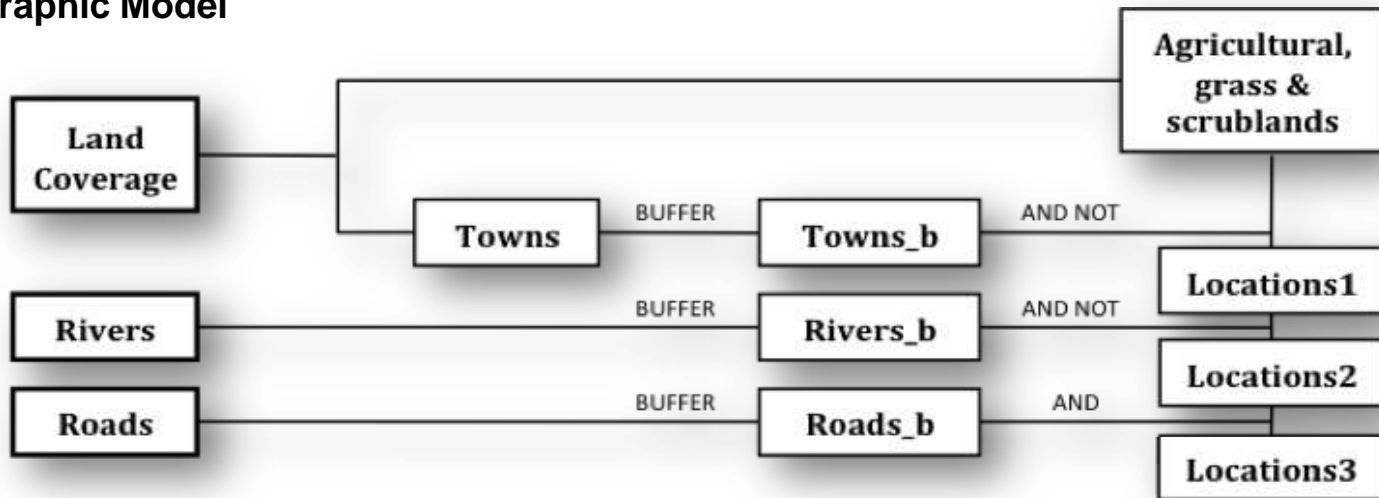
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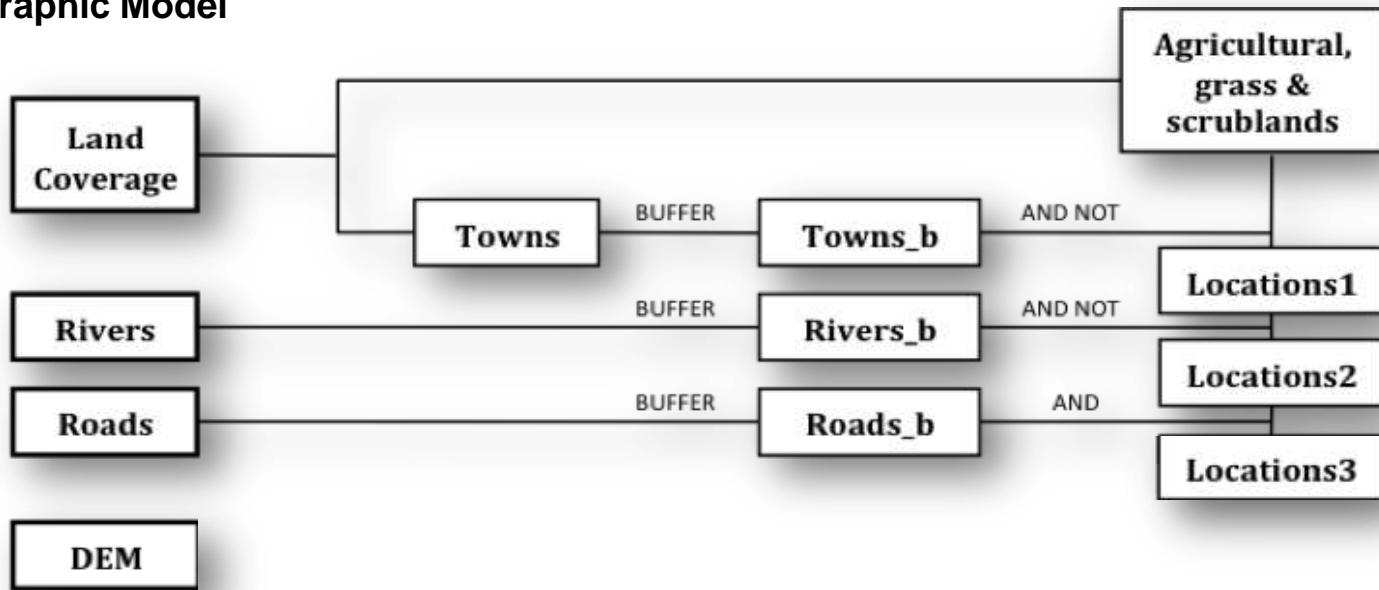
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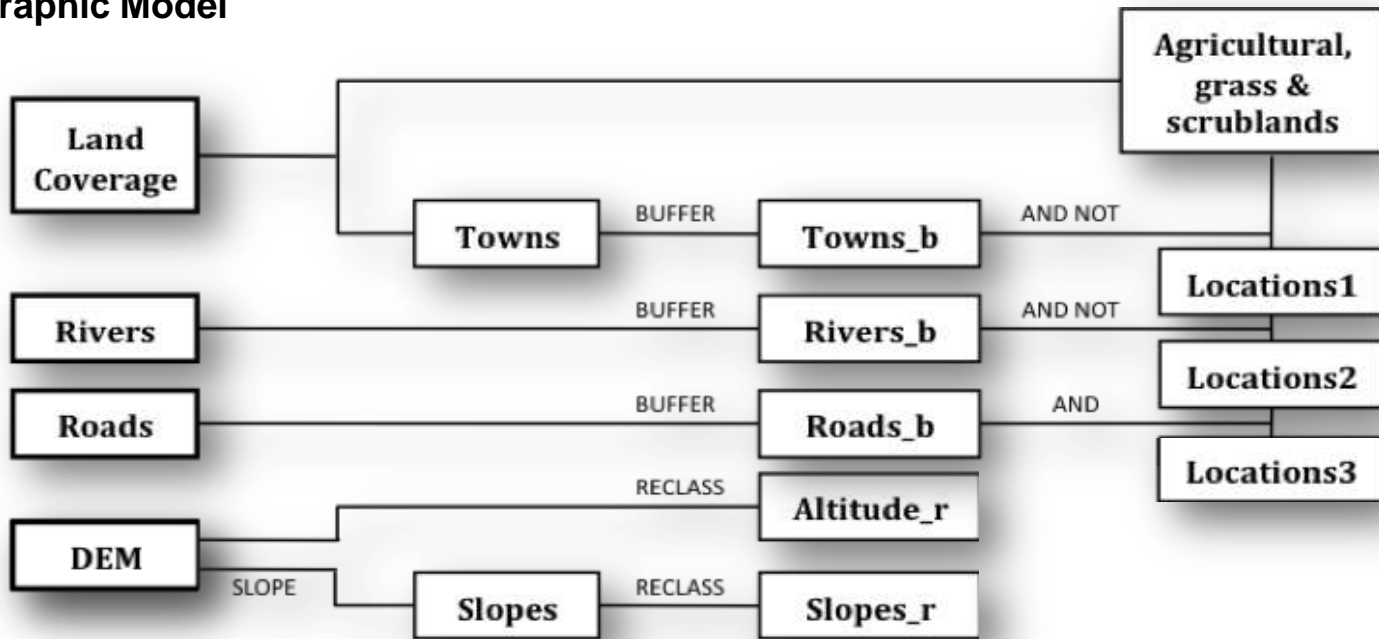
Geographical analysis

Cartographic Model



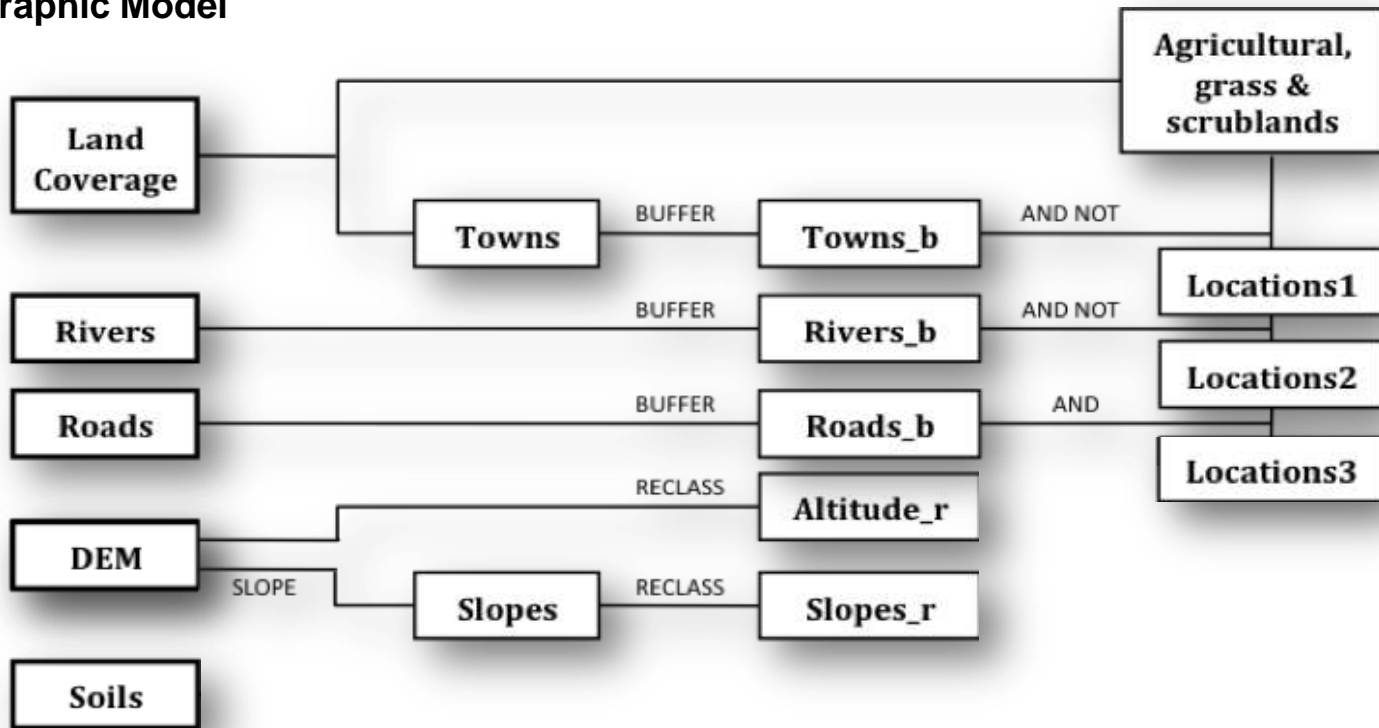
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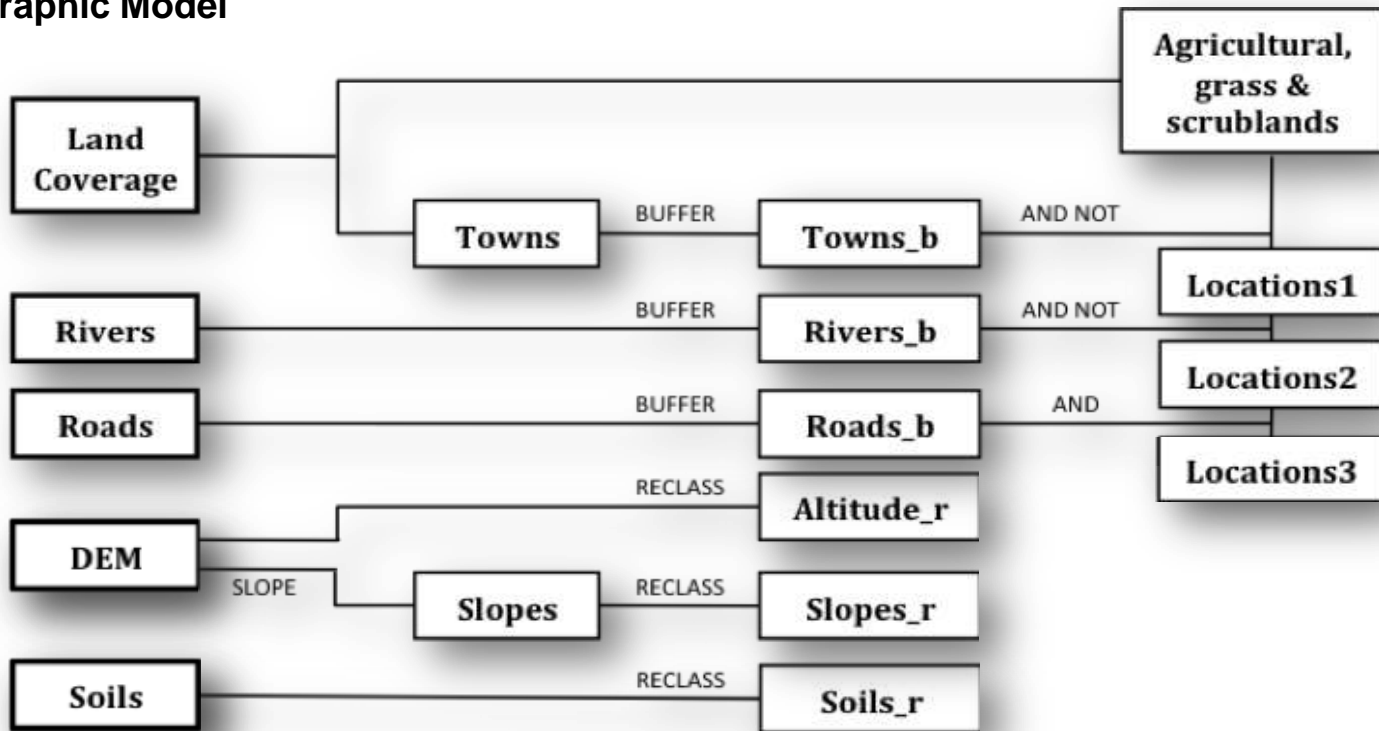
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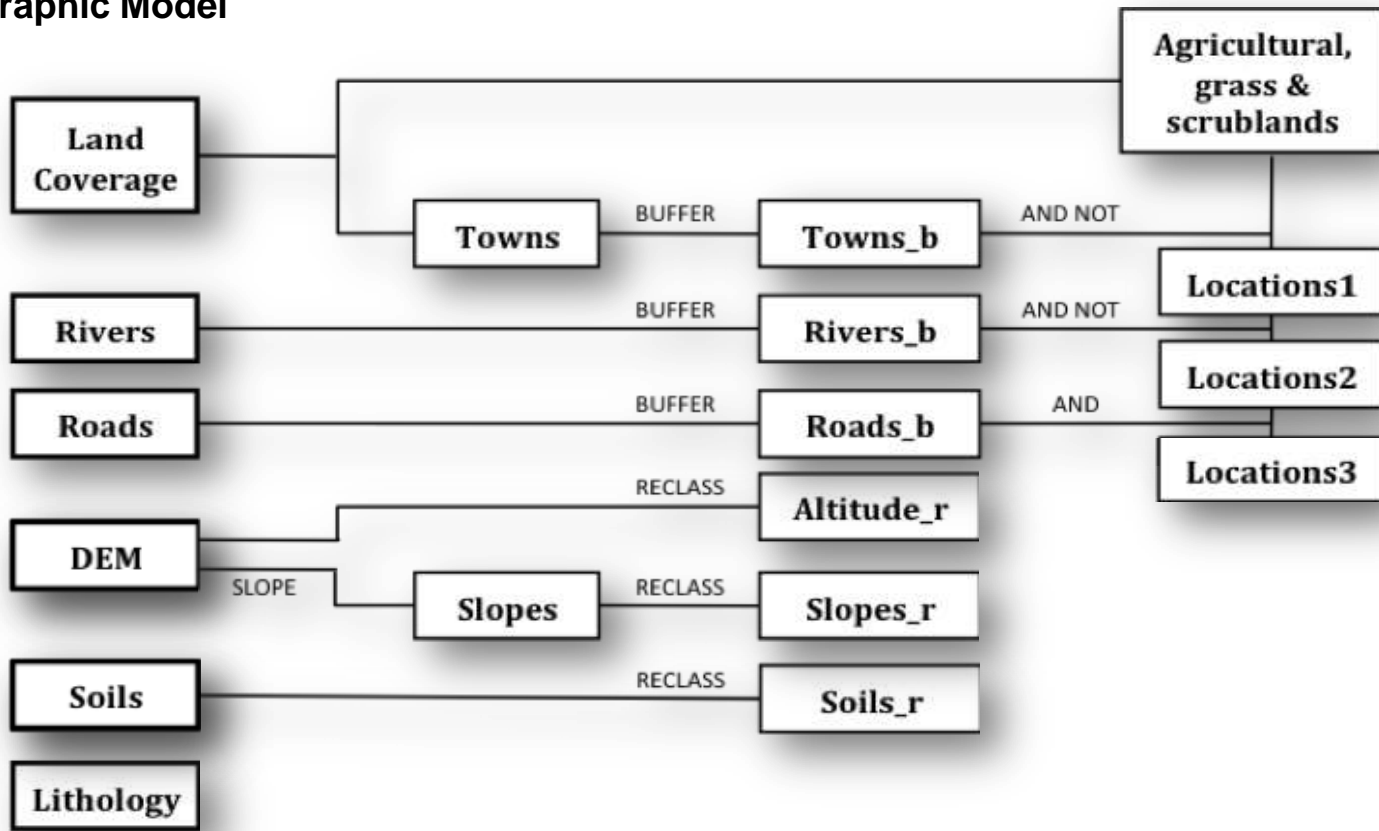
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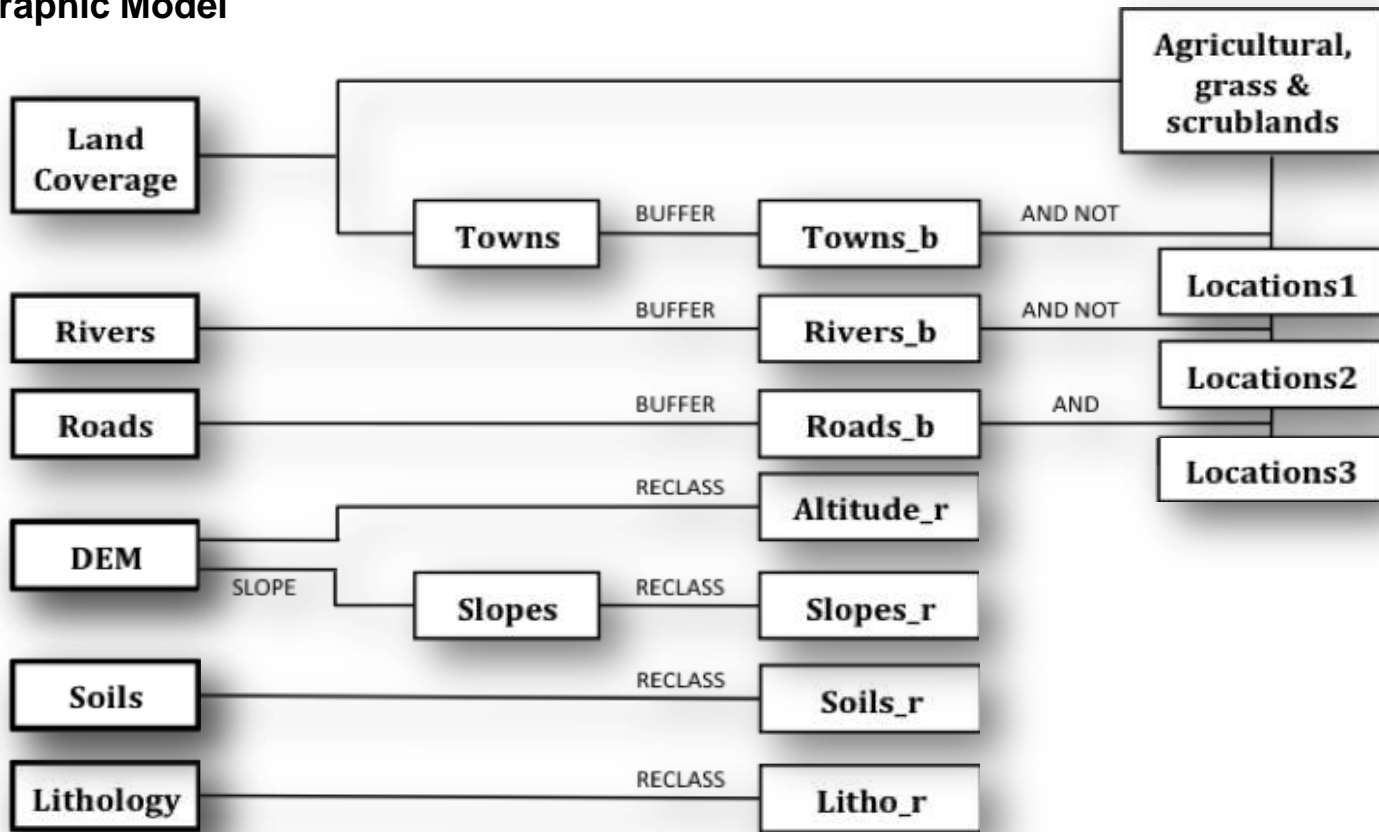
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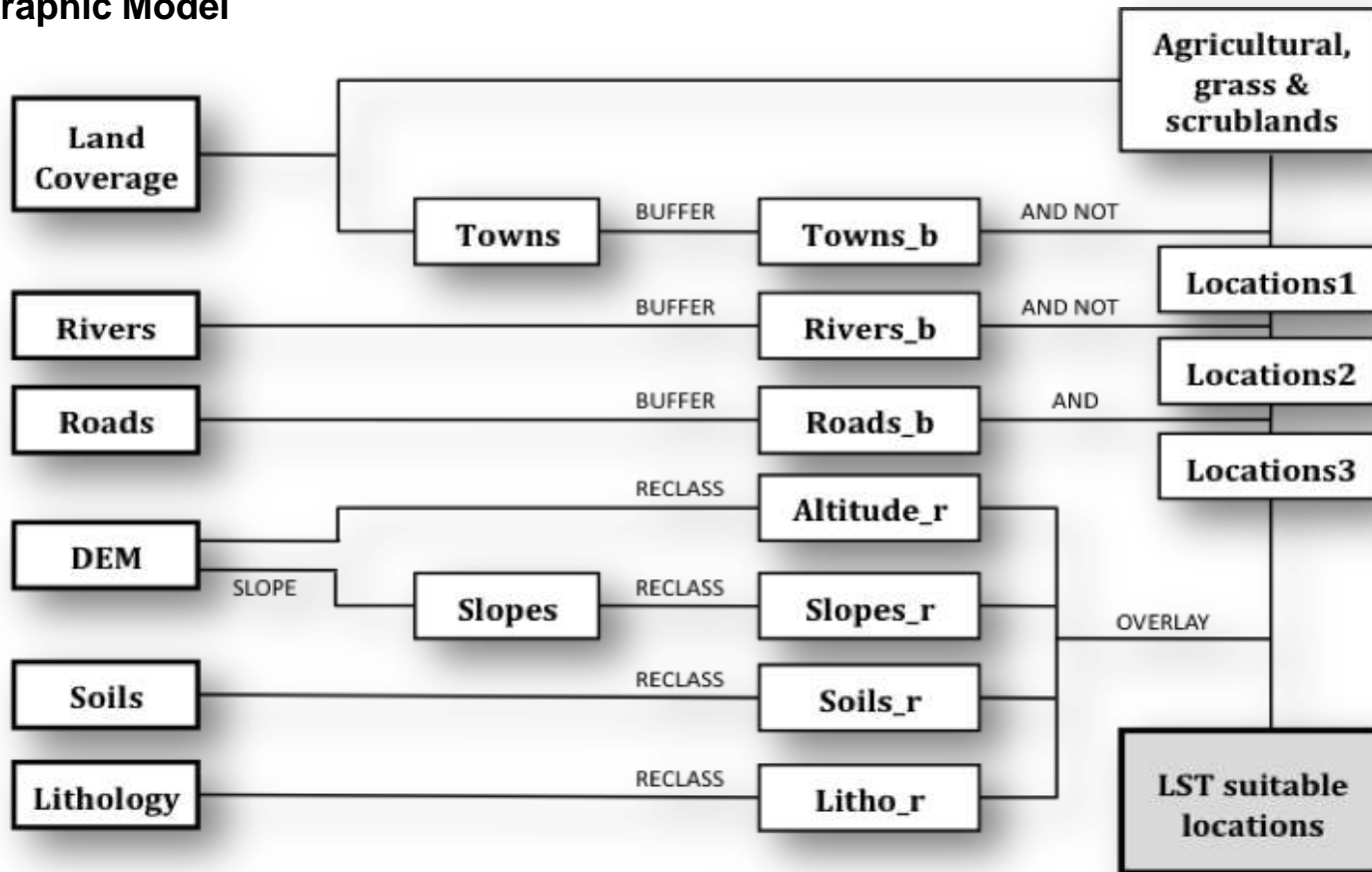
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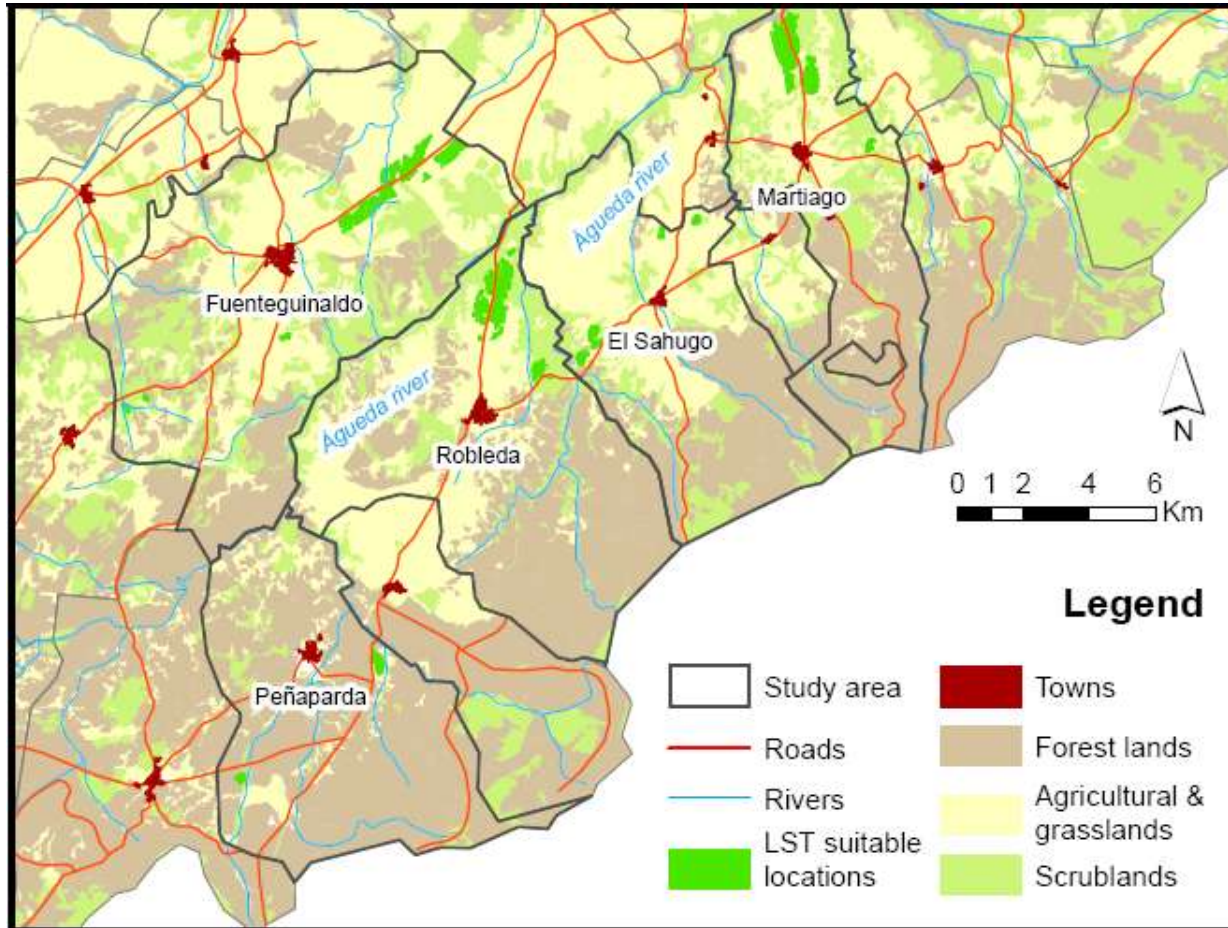


Geographical analysis

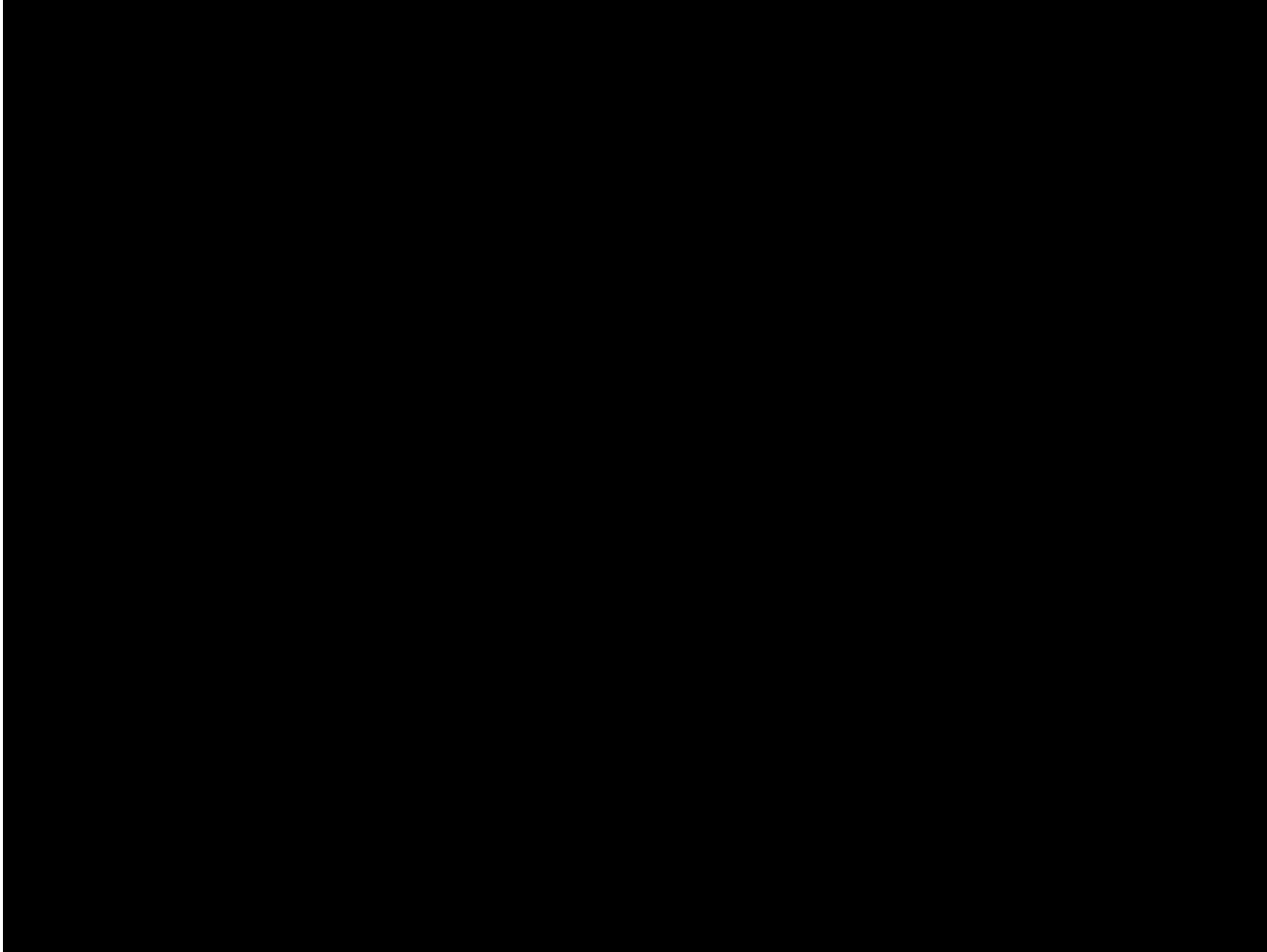
Cartographic Model



LST suitable locations



Visual Impact



Conclusions

1. Small area, less than 1 ha/350 inhab. (e.g. Fuenteguinaldo 1ha/450 inhab.)
2. Sturdy and low maintenance system, no need for qualified service personnel.
3. Ability to absorb flow increases during summer time.
4. Environmental improvements:
 - Indirect high quality water reuse, through aquifer recharge (76.500 m³/year).
 - High economic value biomass production.
 - Landscape improvement
 - New habitat

References

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