

What's a River?

A Foundational Approach to a Domain Reference Ontology for Water

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Ressources naturelles
Canada

Natural Resources
Canada

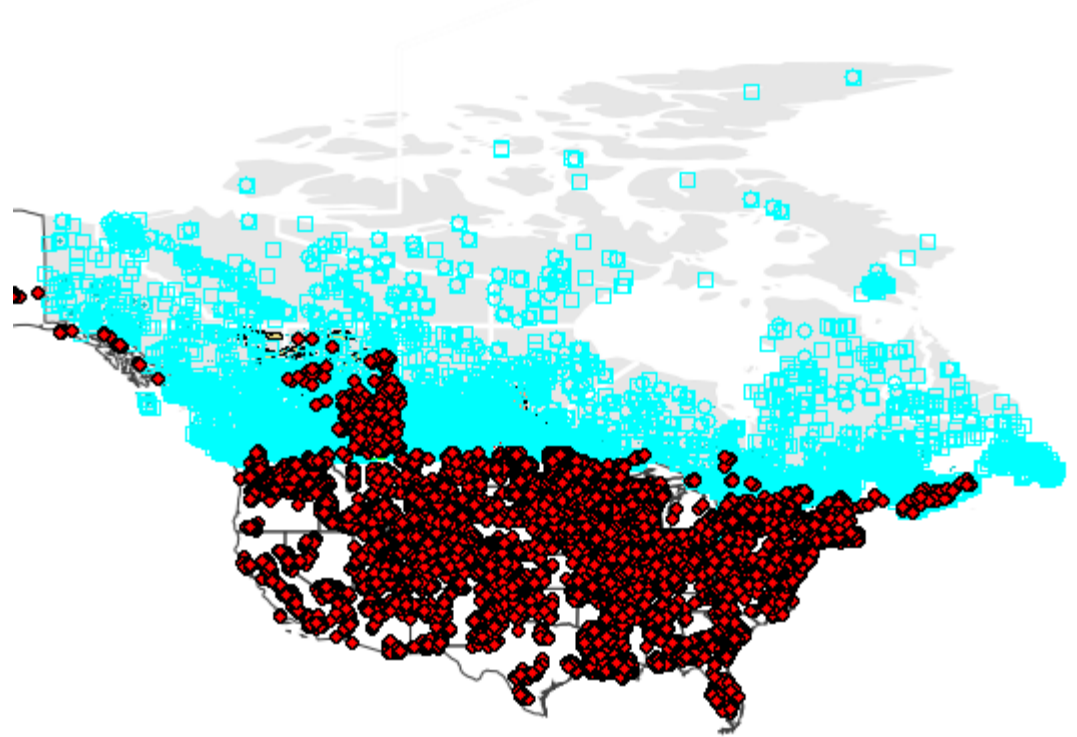
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Water Data Networks

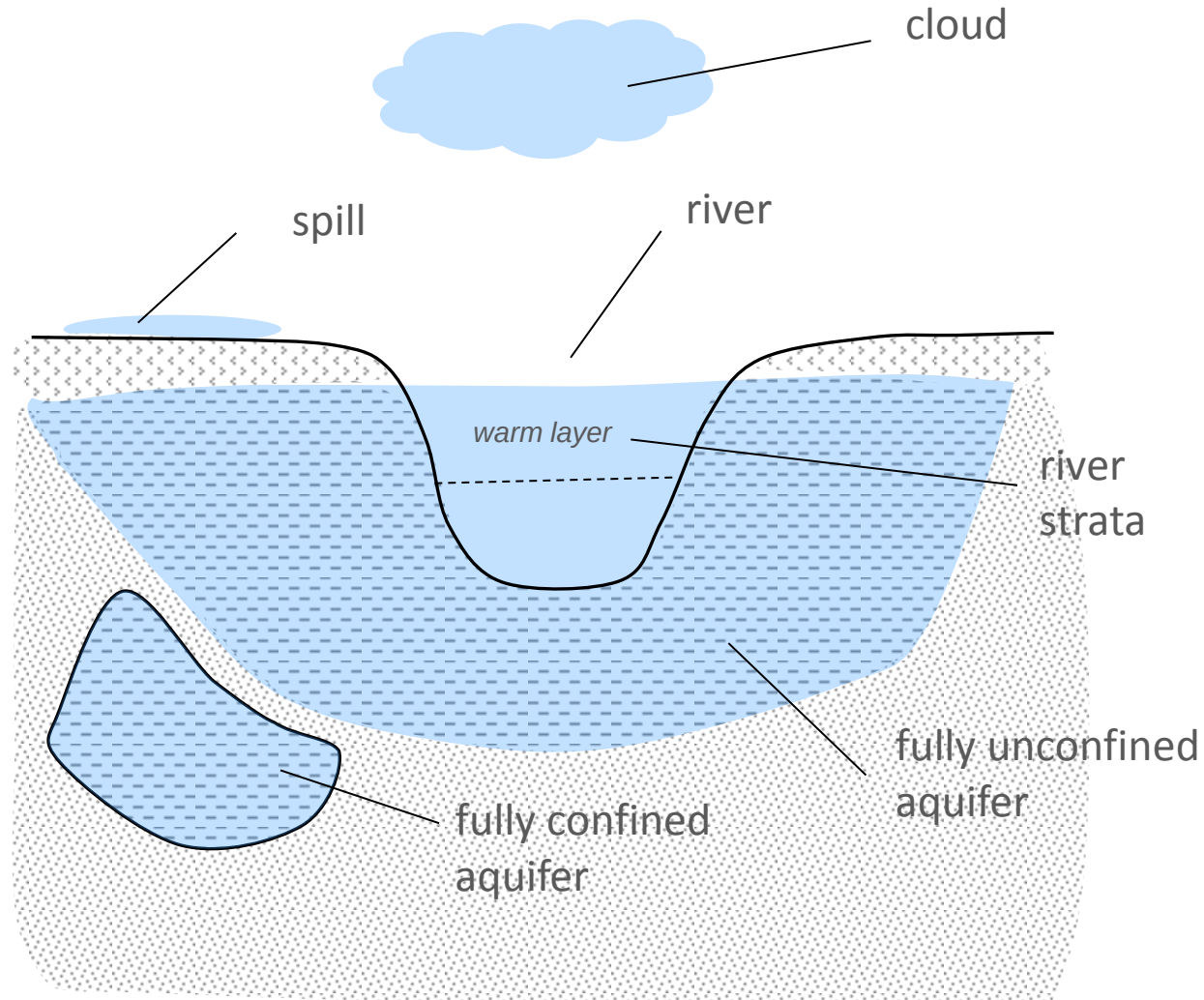
- **rise of water data networks**
 - surface water
 - groundwater
 - atmospheric water
- **sensor & water body sub-networks**
 - millions of sensors
 - billions of readings
 - thousands of water bodies



Groundwater Information Network (CAN)
Nat'l Groundwater Monitoring Network (USA)



Water Body Examples





Water Body Ontologies

■ Semantic heterogeneity for water body

river = void + water object (Hayes, 1978)

river = container + water object (Galton & Mizoguchi, 2009)

river = water object (Hart et al., 2007; SWEET 2011)

river = possibly not water matter: 'dry river' (Duce & Janowicz, 2010)

water body = container (channel) (SWEET 2011)

water body = water object (Hahmann & Brodaric, 2012)

water body = lake-like / water object / matter (Sinha et al., 2012)

water body = water object / matter (Hart et al., 2007; INSPIRE, 2013)

water body = container / water matter (Dornblut & Atkinson, 2014)

water body = lake-like (Strassberg et al., 2011, Morehouse, 2002)



Domain Reference Ontologies

Tiered domain ontology

- **Domain reference ontology**
driven by foundational principles
Hydro Foundational Ontology (HyFO)
- **Domain mid-level ontology**
driven by domain characteristics: e.g. river vs stream vs lake vs pond

Foundational (Upper) Ontology	
Domain Ontology	
<i>Domain Reference Ontology:</i>	<i>HyFO Water Feature</i>
<i>Domain Mid-level Ontology:</i>	<i>INSPIRE River, river vs stream,...</i>
Application Ontology	<i>Spanish River</i>



Ontology For Liquids (Hayes 1978)

LAZY STILL	LAZY MOVING	ENERGETIC MOVING		
Wet surface	Flowing down a surface, e.g. a sloping roof.	Waves lapping shore(?) jet hitting a surface(?)	ON SURFACE	BULK
Contained, in container	Flowing along a channel, e.g. river.	Pumped along pipeline.	IN SPACE	
X	Falling column of liquid, e.g. pouring from a jug, or waterfall.	Waterspout, fountain, jet from hosepipe.	UNSUPPORTED	
Dew, drops on a surface.	X	X	ON SURFACE	DIVIDED
Mist filling a valley (?)	Mist rolling down a valley (?)	steam or mist blown along a tube (?)	IN SPACE	
Mist, cloud.	Rain, shower.	spray, splash, driving rain.	UNSUPPORTED	

movement

uncontained

contained

uncontained

etc.

supported

unsupported

connectivity

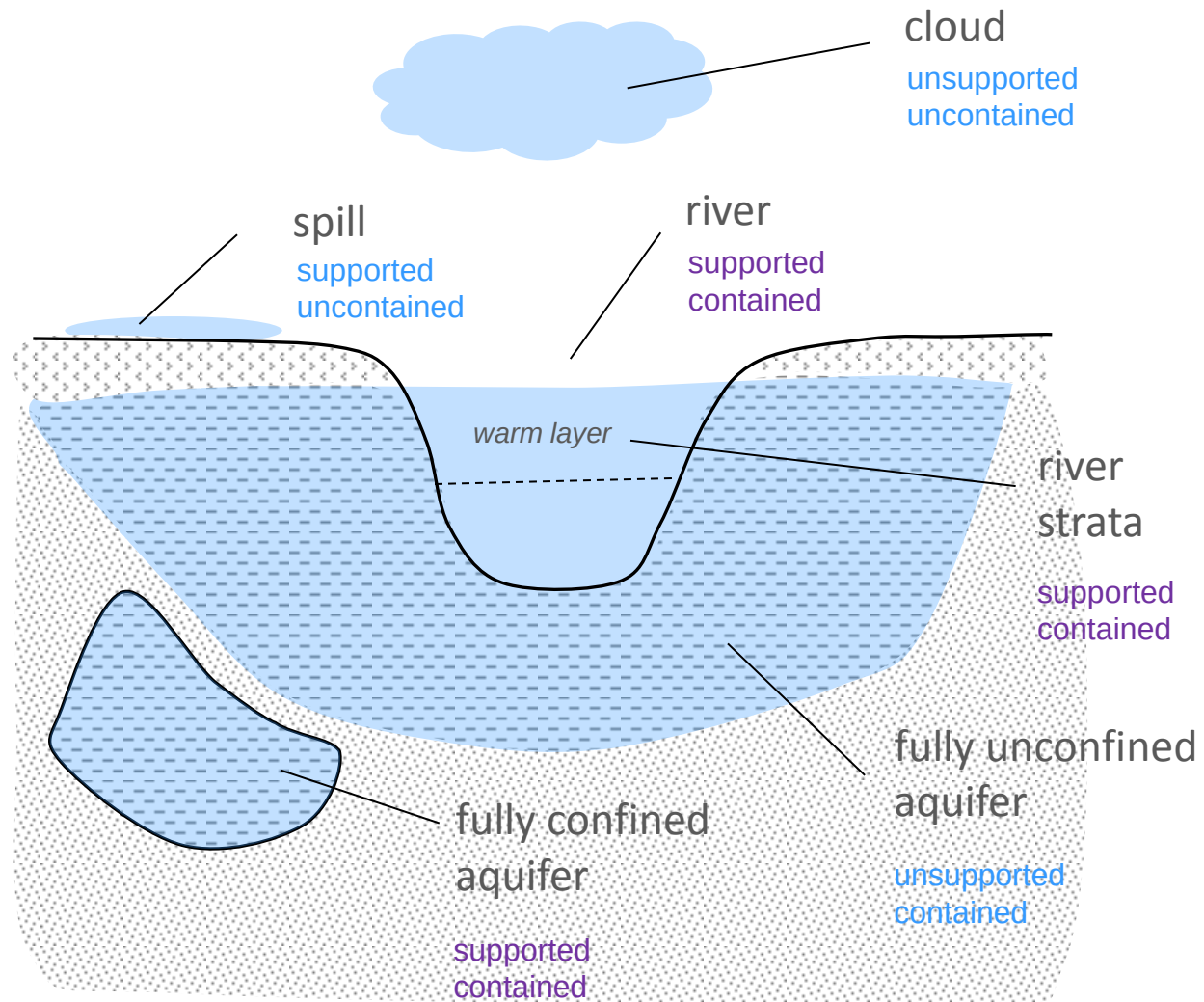


Ontology For Liquids (Hayes 1978)

Foundations

- supported
- unsupported
- contained
- uncontained
- dependent

re: water matter

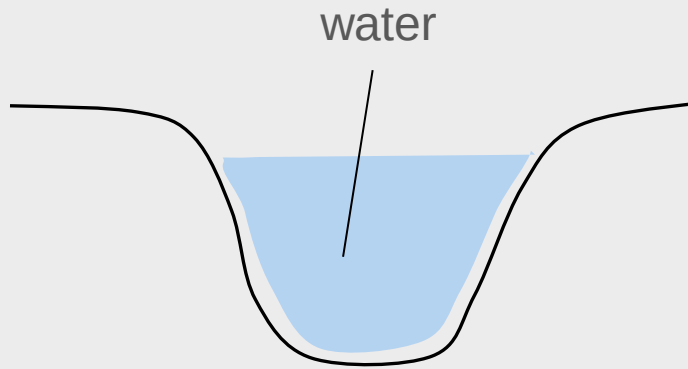




Foundations: containment & dependence

■ independent (detachable) containment

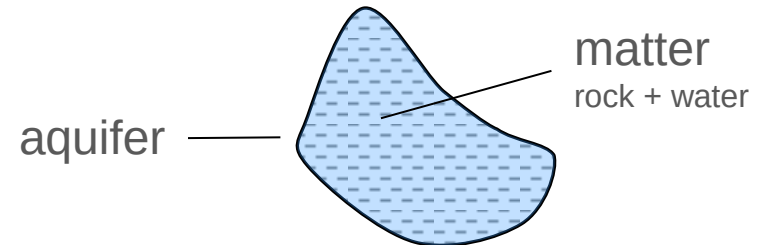
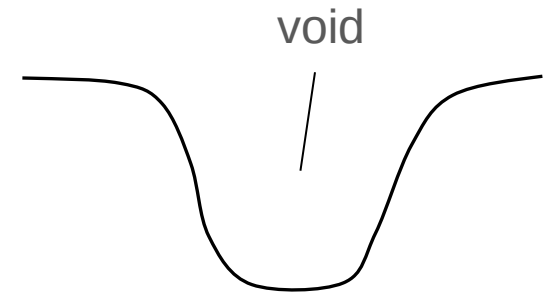
e.g. water in container
objects are independent



Hahmann & Brodaric, 2013

■ dependent containment

e.g. void hosted by container
object constituted by matter
change in one = change in other

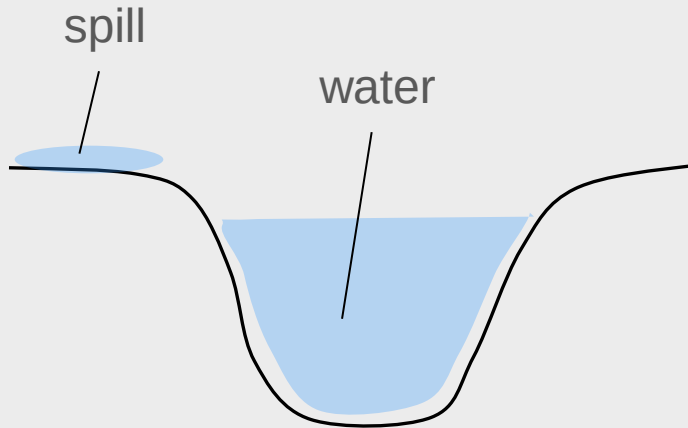




Foundations: support & dependence

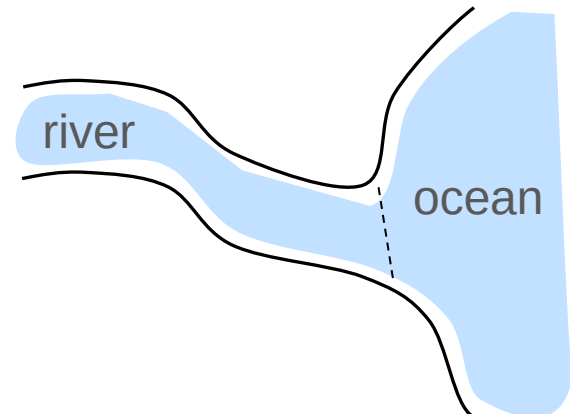
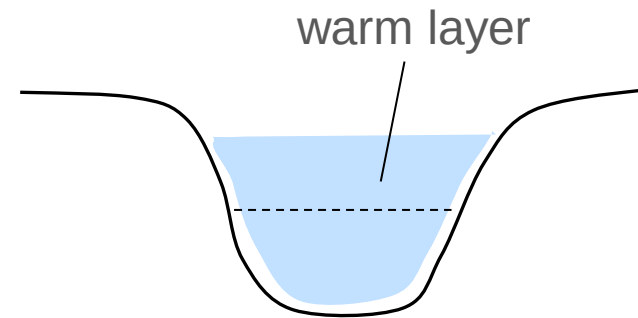
■ independent support

e.g. water supported by container
e.g. spill supported by ground surface
supporting boundary (bona-fide) not hosted by supported object



■ dependent support

e.g. strata in water body
supporting boundary (fiat) hosted by supported object

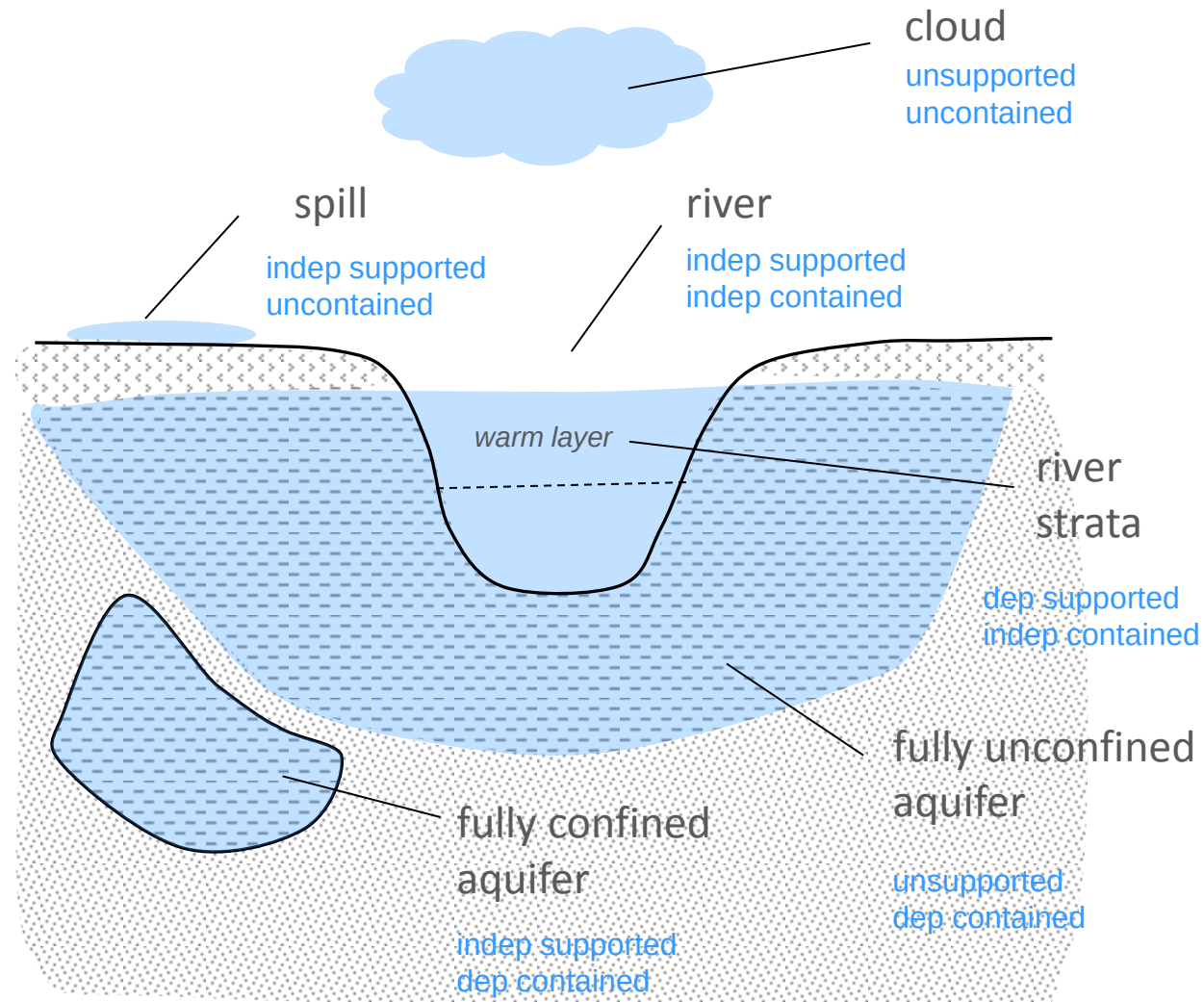




Ontology for Liquids: enhanced

Foundations

- **supported**
 - dep supported
 - indep supported
- **unsupported**
- **contained**
 - dep contained
 - indep contained
- **uncontained**



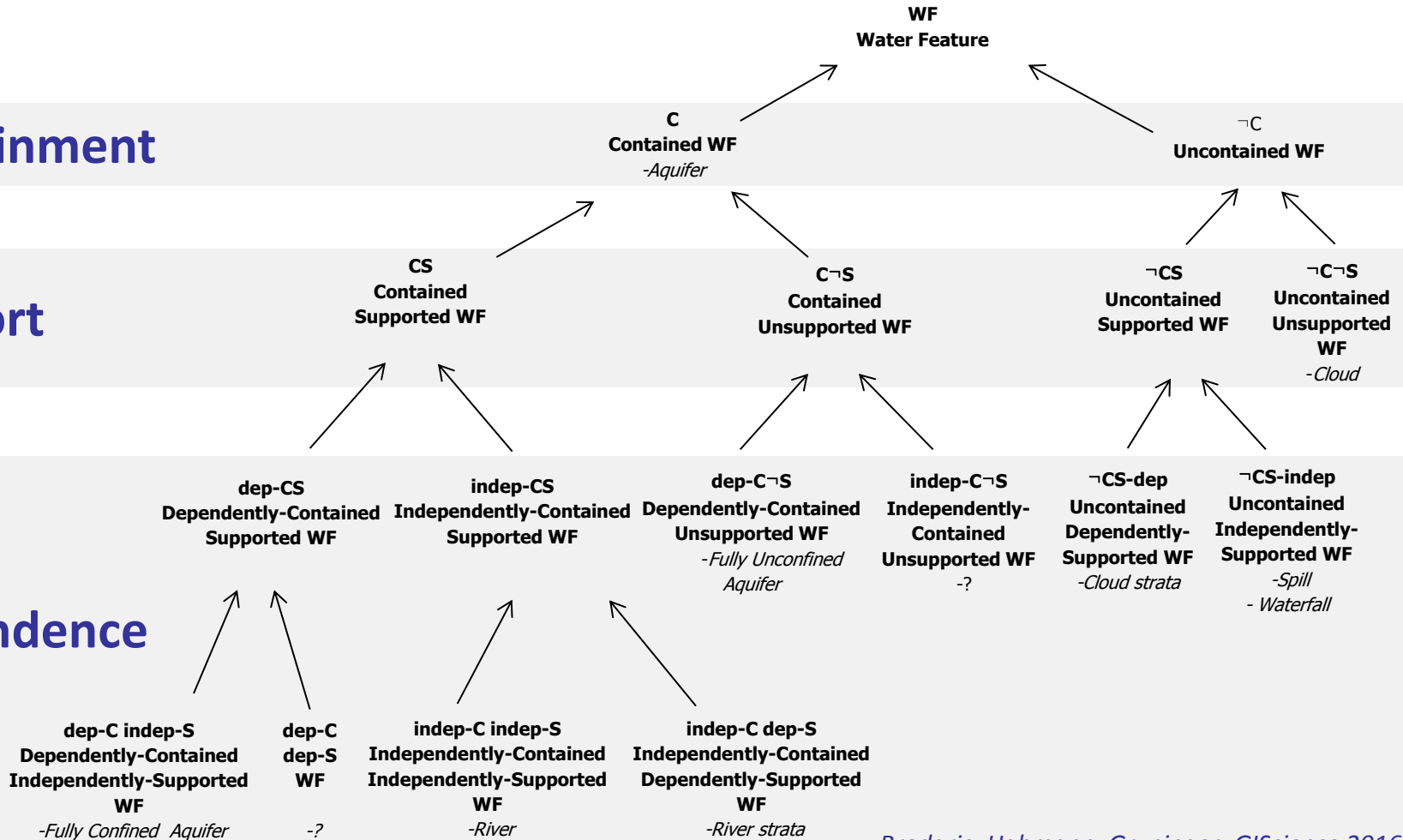


Water Body Taxonomy

■ containment

■ support

■ dependence

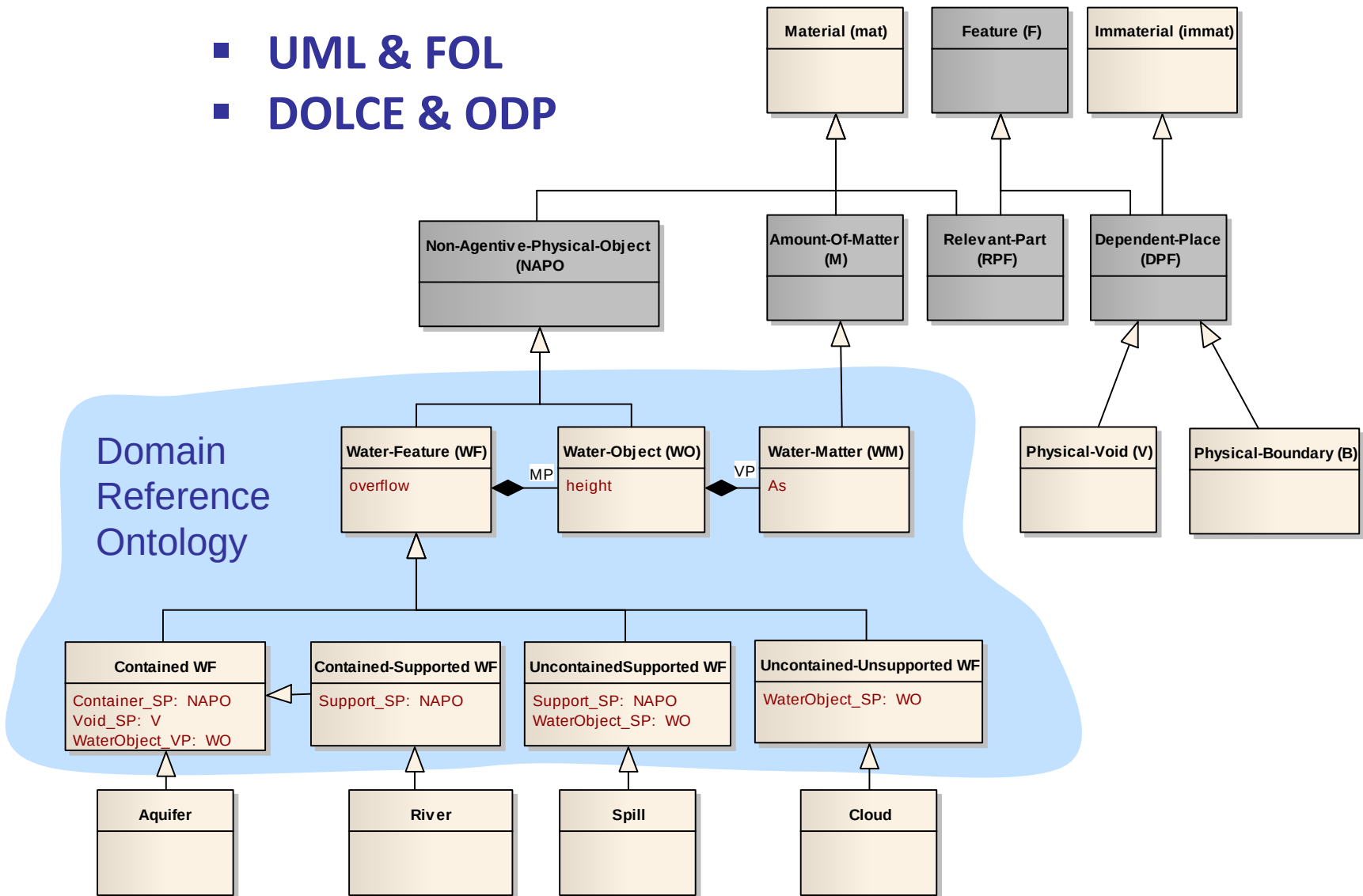


Brodaric, Hahmann, Gruninger: GIScience 2016



Water Body Ontology

- UML & FOL
- DOLCE & ODP





Concluding Thoughts

Recap

- **Foundations for a water body reference ontology minimally include three structuring relations**
containment, support, dependence

Questions

- **Other foundations?**
parthood, movement (e.g. rapids)? connectivity (e.g. rain drops)?
- **Further testing?**
fit with cognitive, cultural, and linguistic diversity?

Next Steps

- **Complete formalization and papers**



■ Questions?

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