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HYDROGEOLOGICAL AND GEOCHEMICAL MODELLING OF A SEA-WATER INTRUSION BARRIER IN AN ISLAND/COASTAL GROUNDWATER BODY

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BACKGROUND

Total surface area:
316km^2.

Population density:
1400inh/km^2

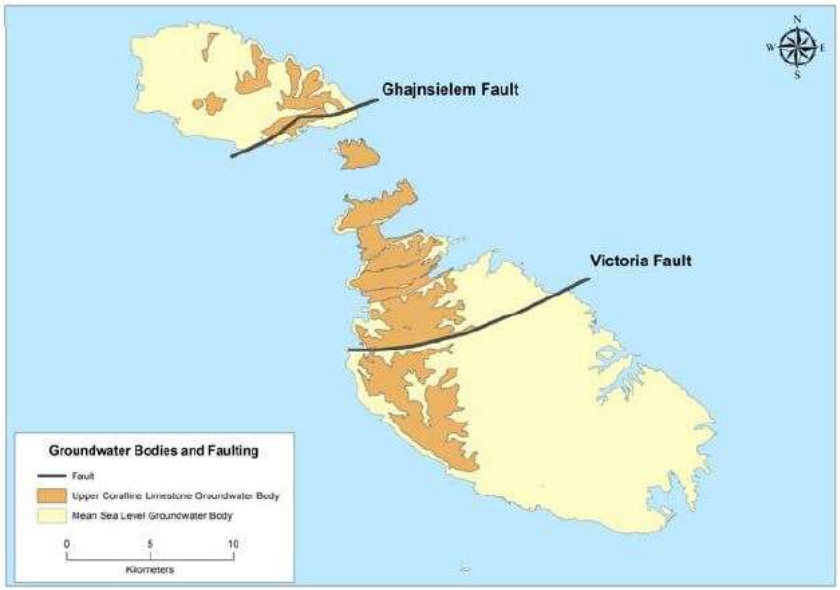
Urban land-cover: 25%

Climate: Semi arid Mediterranean

Mean Annual Rainfall:
550mm

High inter- and intra-annual variability

Natural water availability:
70m^3/cap/year



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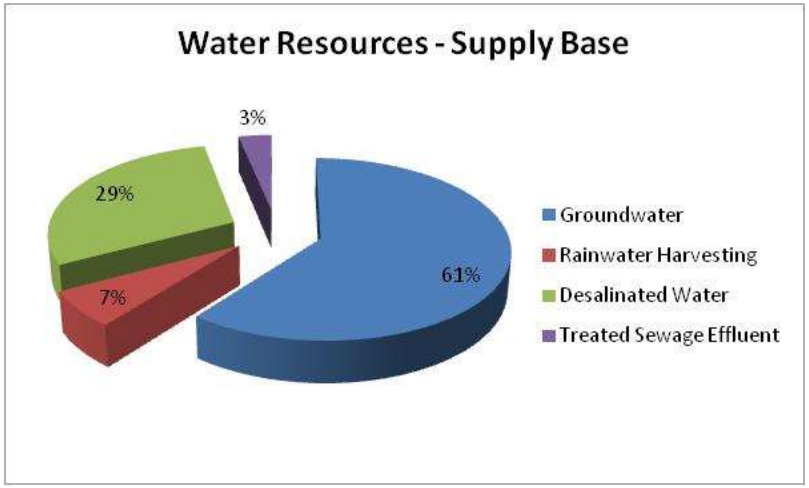
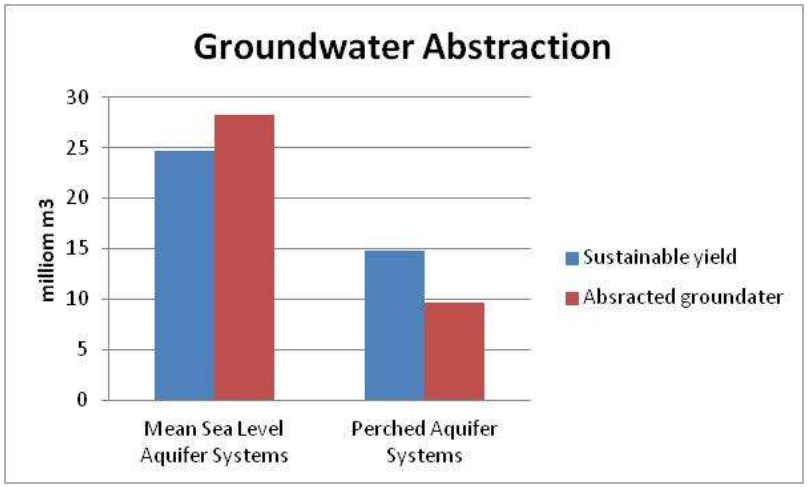
BACKGROUND

IMPORTANCE OF GROUNDWATER





Parameter	LTAA	2014	Comments
Precipitation (hm3)	174	159	
Actual Evapotranspiration (hm3)	109	100	assumed at 63% of total precipitation in both cases
Renewable Water Resources (hm3)	65	59	
Natural Subsurface Discharge (hm3)	24	24	assumed at 50% of the long term annual recharge to the MSLA systems
Unrecoverable Surface Runoff (hm3)	4	4	estimated at 25% of total surface runoff generated (initial estimate)
Actual available Water Resources (hm3)	37	31	
Total Abstraction / Utilisation (hm3)	38	42	
Returned Water (hm3)	12	12	return from municipal supply leakages and irrigation
WEI+	78%	97%	

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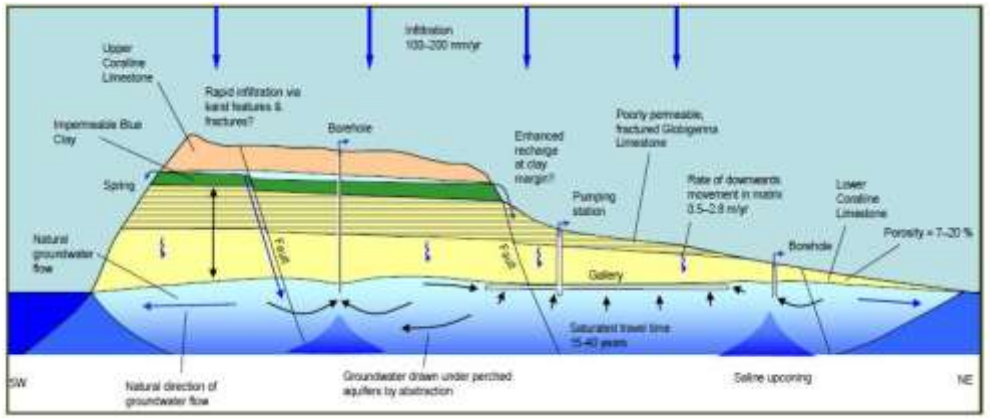
SEA-LEVEL GWB

(i) Sustained in the Lower Coralline Limestone formation, which lies beneath the whole island (and locally in the Globigerina formation);

(ii) In direct lateral and vertical contact with sea-water;

(iii) Capped in certain areas by the impermeable Blue Clay formation and more extensively by less permeable strata of the Middle Globigerina Limestone (considered more as offering increased protection to the aquifer rather than confining it);



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SEA-LEVEL GWB

(iv) Abstraction leads to saline upconing and an increase in salinity;

(v) Low porosity implies that the rate of downward movement in the aquifer will be greater than in the perched aquifer, but the unsaturated travel time will be longer in the thicker parts of the aquifer;

(vii) Limited detection of coliforms indicate that rapid transport from the surface to the aquifer is limited;

(viii) Residence time in the saturated zone is in the range of 15-40 years;

(ix) Low estimates of transmissivity from pumping tests suggests that movement in enlarged solution features is limited (primary permeability prevails);

(x) Region of the aquifer capped by the Blue Clay is recharged through different mechanisms (slow direct infiltration, preferential infiltration at edge of clay and rapid infiltration at faults/fractures)

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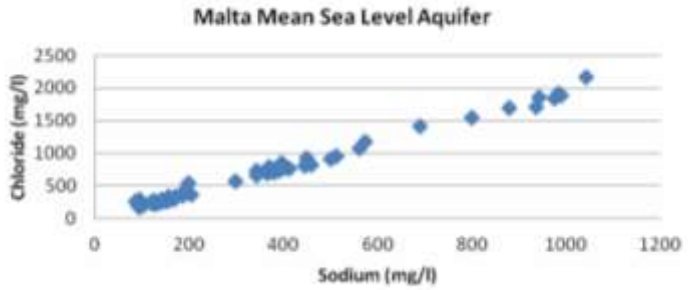
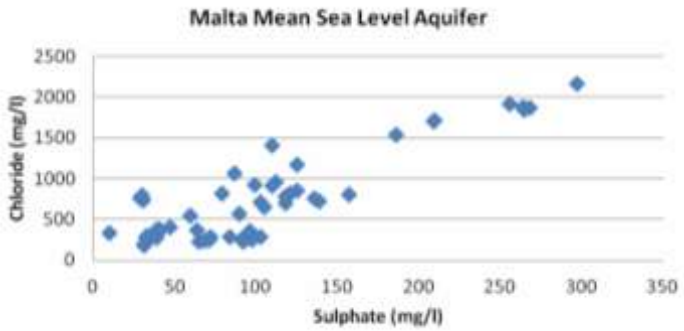
GEOCHEMICAL CHARACTERISTICS

Outline of basic geochemical characteristics of groundwater

Chloride-Conductivity etc

And relate to aquifer matrix - carbonate





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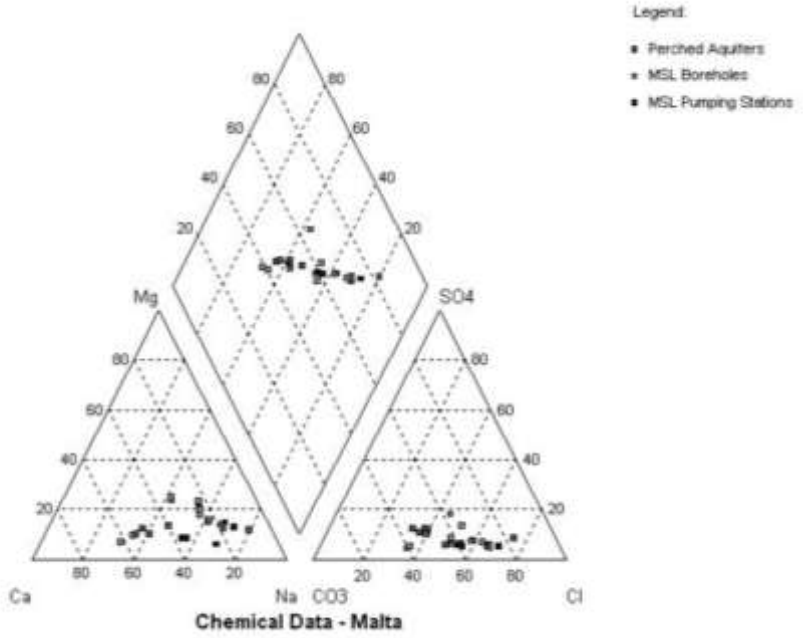
GEOCHEMICAL CHARACTERISTICS

Relate to sea-water intrusion



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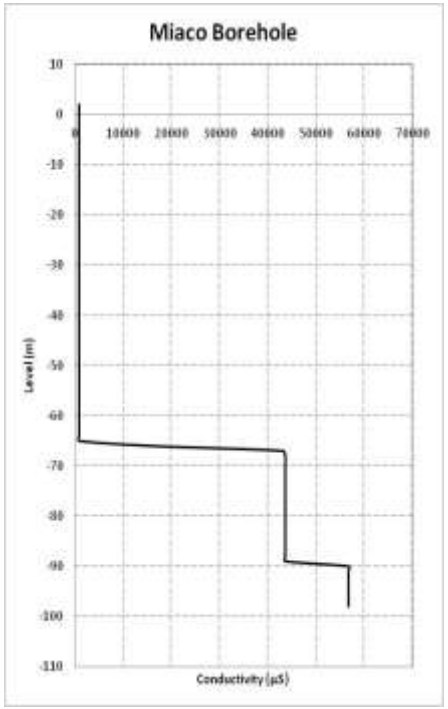
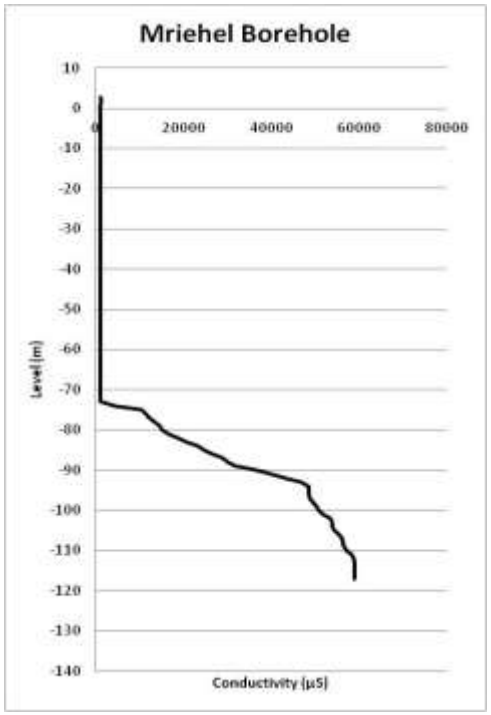
GEOCHEMICAL CHARACTERISTICS

Vertical distribution of salinity





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MARSOLUT

Objectives:

- Numerical Model for the MSLA
  Simplified conceptual model suitable for karst aquifers
- Regulatory framework
  More in-depth for Malta South case study, also helpful to EU framework
- Monitoring framework
  Identification of key-parameters for monitoring
- Pilot MAR application
  Field activities

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NUMERICAL MODEL

Main issues to be tackled: sea-water intrusion & freshwater supply availability

- Generate (and validate) conceptual and numerical models to assess the application of different MAR techniques for the development of a sea-water intrusion barrier, giving due consideration to hydrogeological variations in the aquifer matrix.
- Development of a conceptual understanding of how a sea-water intrusion barrier can be applied to an island/coastal groundwater body.
- Testing of scenarios for the application of different MAR techniques.

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REGULATORY FRAMEWORK

Contribution which MARSOLUT can give to water management in Malta

- Development of an in-depth assessment of the EU regulatory framework leading to the development of a comprehensive framework suitable for the Maltese Island.

- Guidance for the application of future MAR schemes and hence ensuring their alignment to the requirements of the Water Framework Directive and Groundwater Directive.

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MONITORING FRAMEWORK

WFD requirements and Risk Assessment

- Extensive qualitative (geochemical) characterisation of the Mean Sea Level Aquifer system.

- Identification of key-monitoring parameters which would then be proposed for monitoring the impact of the eventual MAR scheme.

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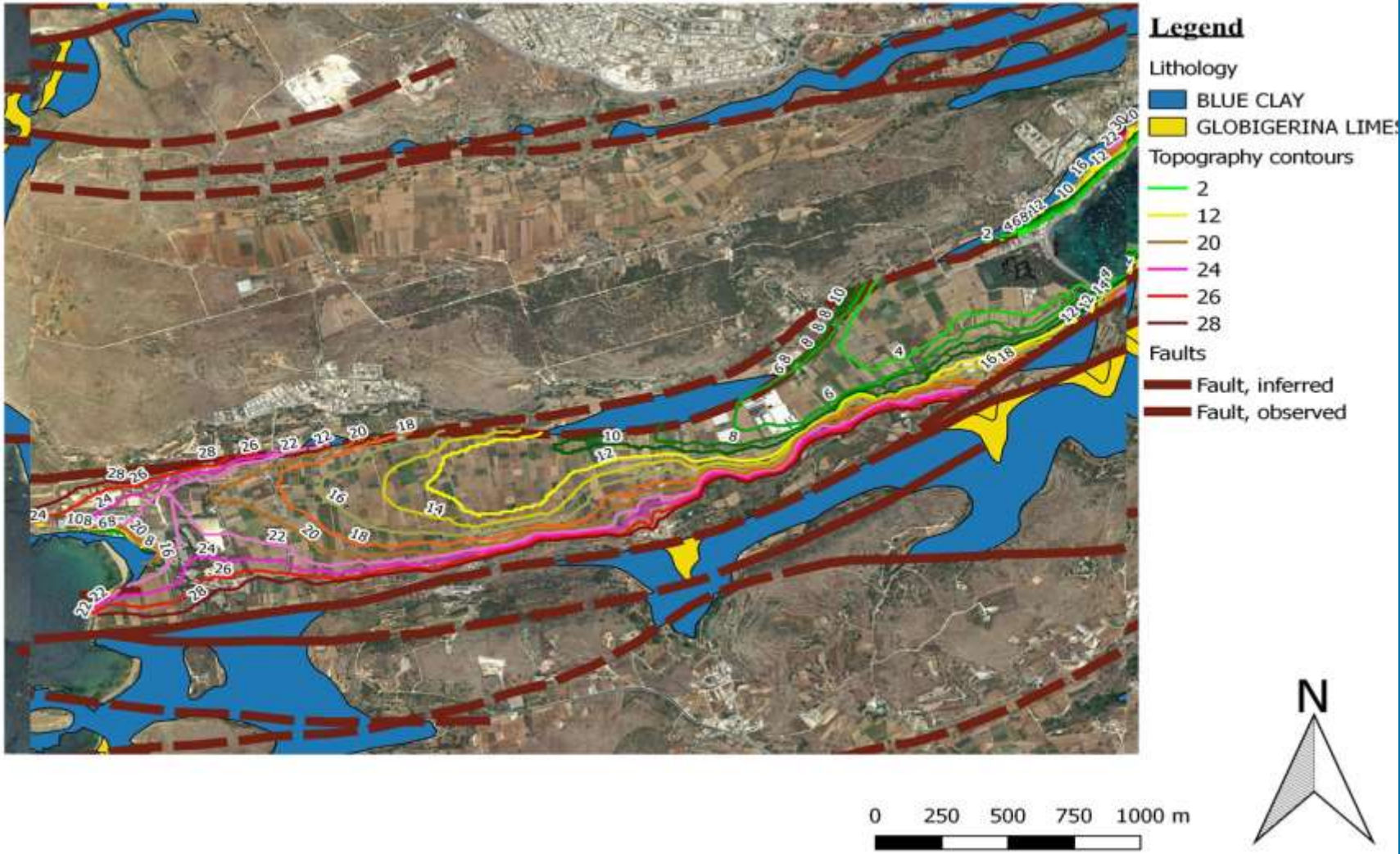
PILOT MAR APPLICATION



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PILOT MAR APPLICATION

ISSUES	FIELD ACTIVITY
Shallow depth of Clay formation	Geophysical survey
Lack of qualitative and quantitative data	Water table height measurements and water sampling in private wells
Springs over ridges	Aerial photographic survey (visual and IR) to be undertaken with drones
Different members of Upper Coralline Limestone formation	Geological coring
Hydrogeological parameters assessment	Infiltrometer and slug tests

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CONCLUSIONS

MAR is considered the main solution to enhance the conditions of Malta South aquifer system, coupled with potentially water reuse for agricultural purposes.

The complexity of the aquifer karst in type constrains to conceptualise a simplified conceptual model leading to realistic results.

The contribution expected from MARSoluT project aims at developing a regulatory framework on the management of the MSLA, aligned to Malta's policy outlook and WFD requirements.

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THANK YOU FOR YOUR ATTENTION

QUESTIONS?

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