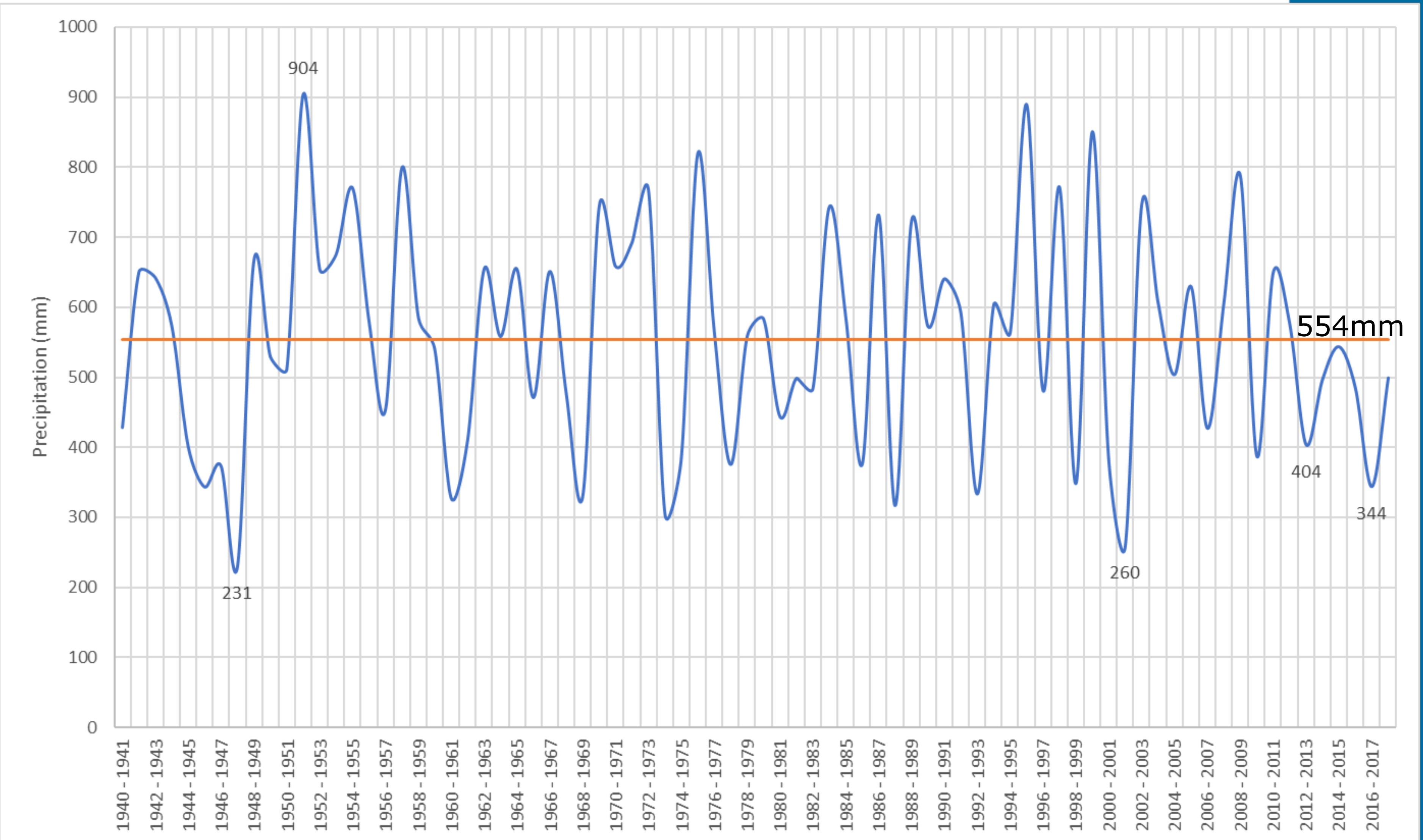
Addressing Global Problems in Local Scales: Water management, history and Trends in Malta

Capacity Building Workshop on
'Communicating Water Trends & Innovation to Engage Locals and Tourists'
12th November, 2019 - MCAST

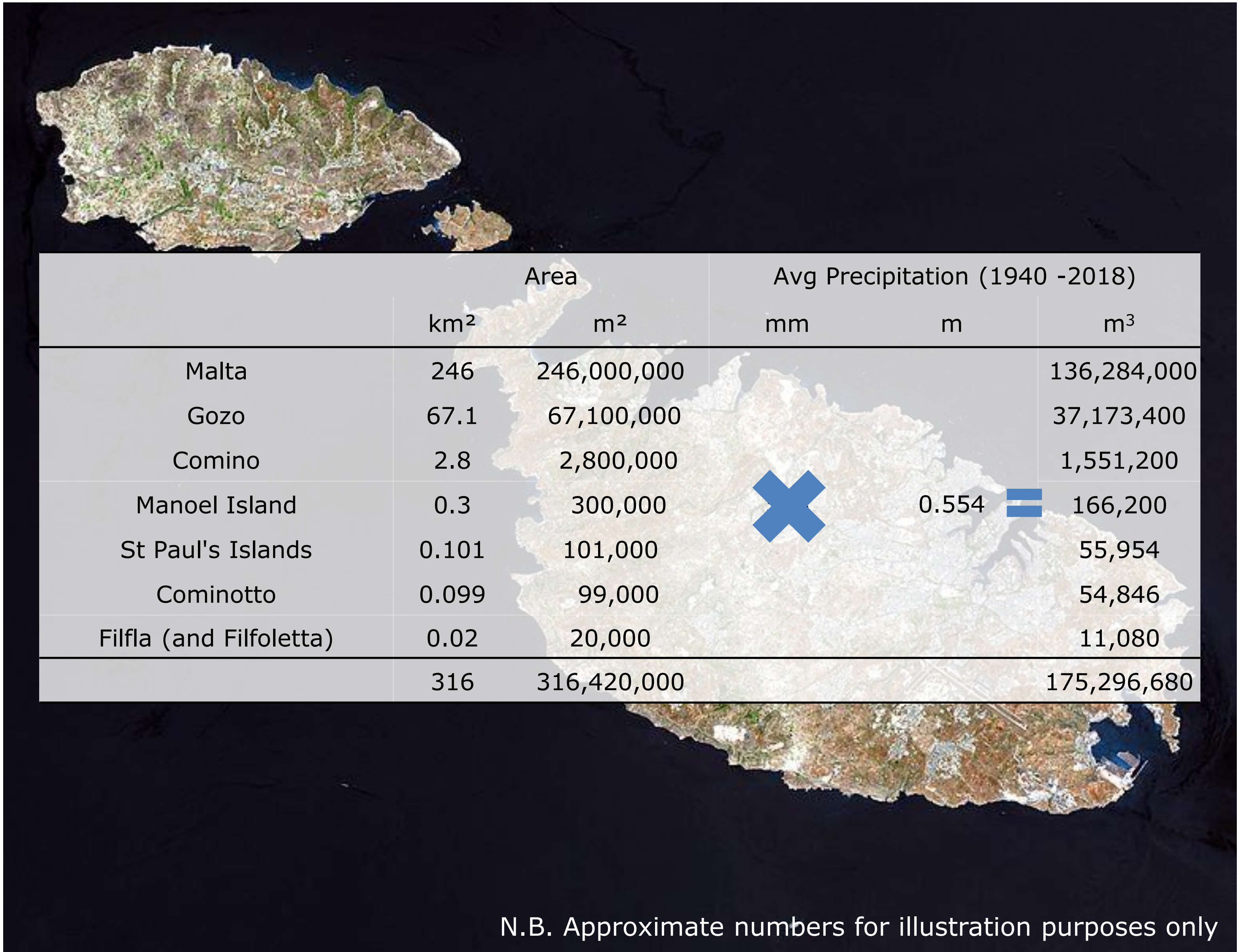
Alter-Aqua III
Non-Conventional Water Resources – Programme in the Mediterranean

Natural Water Resources



Source for data: Malta Airport MetOffice

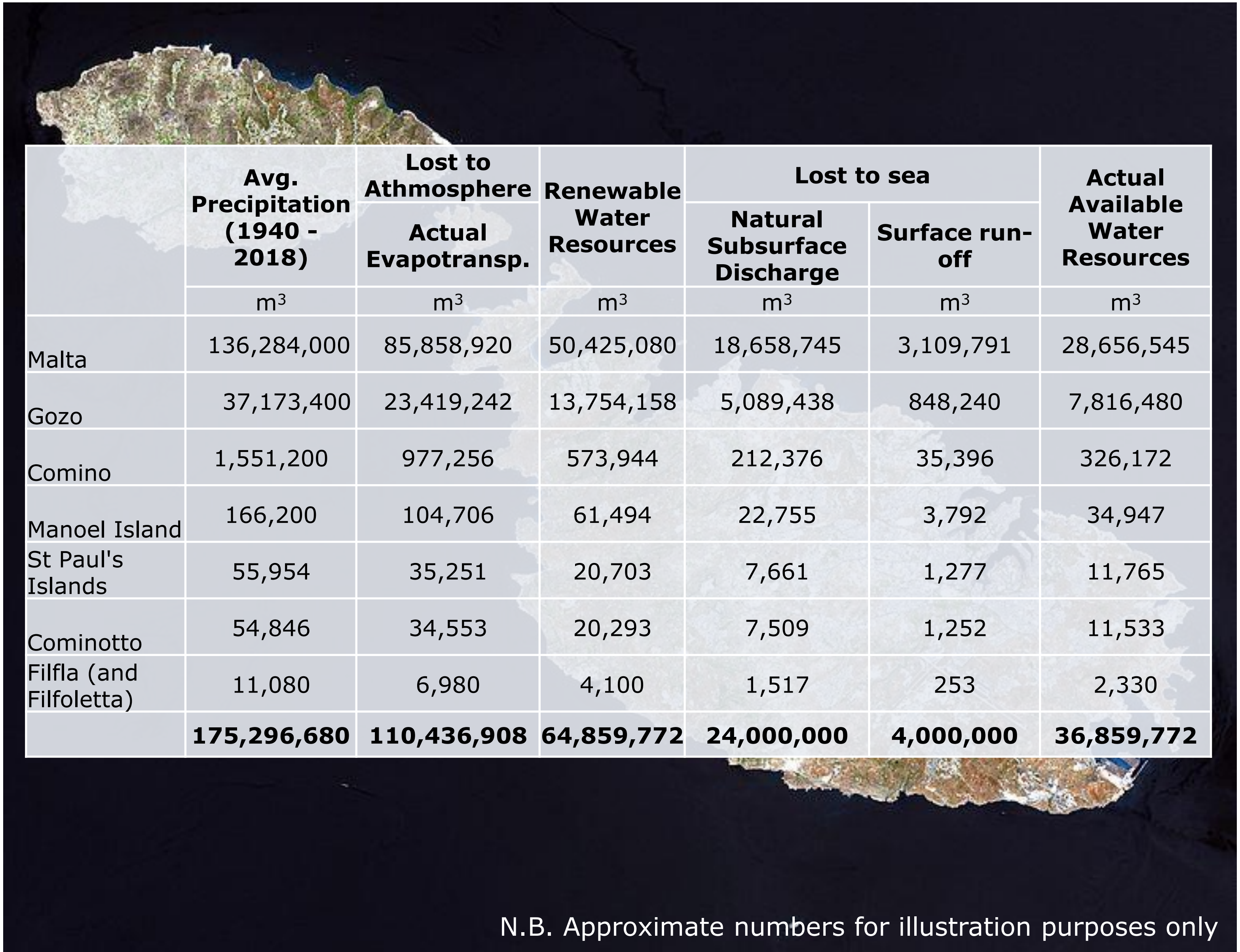
Natural Water Resources



	Area		Avg Precipitation (1940 -2018)		
	km²	m²	mm	m	m³
Malta	246	246,000,000			136,284,000
Gozo	67.1	67,100,000			37,173,400
Comino	2.8	2,800,000			1,551,200
Manoel Island	0.3	300,000	×	0.554 =	166,200
St Paul's Islands	0.101	101,000			55,954
Cominotto	0.099	99,000			54,846
Filfla (and Filfoletta)	0.02	20,000			11,080
	316	316,420,000			175,296,680

N.B. Approximate numbers for illustration purposes only

Natural Water Resources



	Avg. Precipitation (1940 - 2018)	Lost to Athmosphere	Renewable Water Resources	Lost to sea		Actual Available Water Resources
		Actual Evapotransp.		Natural Subsurface Discharge	Surface run-off	
	m^3	m^3	m^3	m^3	m^3	m^3
Malta	136,284,000	85,858,920	50,425,080	18,658,745	3,109,791	28,656,545
Gozo	37,173,400	23,419,242	13,754,158	5,089,438	848,240	7,816,480
Comino	1,551,200	977,256	573,944	212,376	35,396	326,172
Manoel Island	166,200	104,706	61,494	22,755	3,792	34,947
St Paul's Islands	55,954	35,251	20,703	7,661	1,277	11,765
Cominotto	54,846	34,553	20,293	7,509	1,252	11,533
Filfla (and Filfoletta)	11,080	6,980	4,100	1,517	253	2,330
	175,296,680	**110,436,908**	**64,859,772**	**24,000,000**	**4,000,000**	**36,859,772**

N.B. Approximate numbers for illustration purposes only

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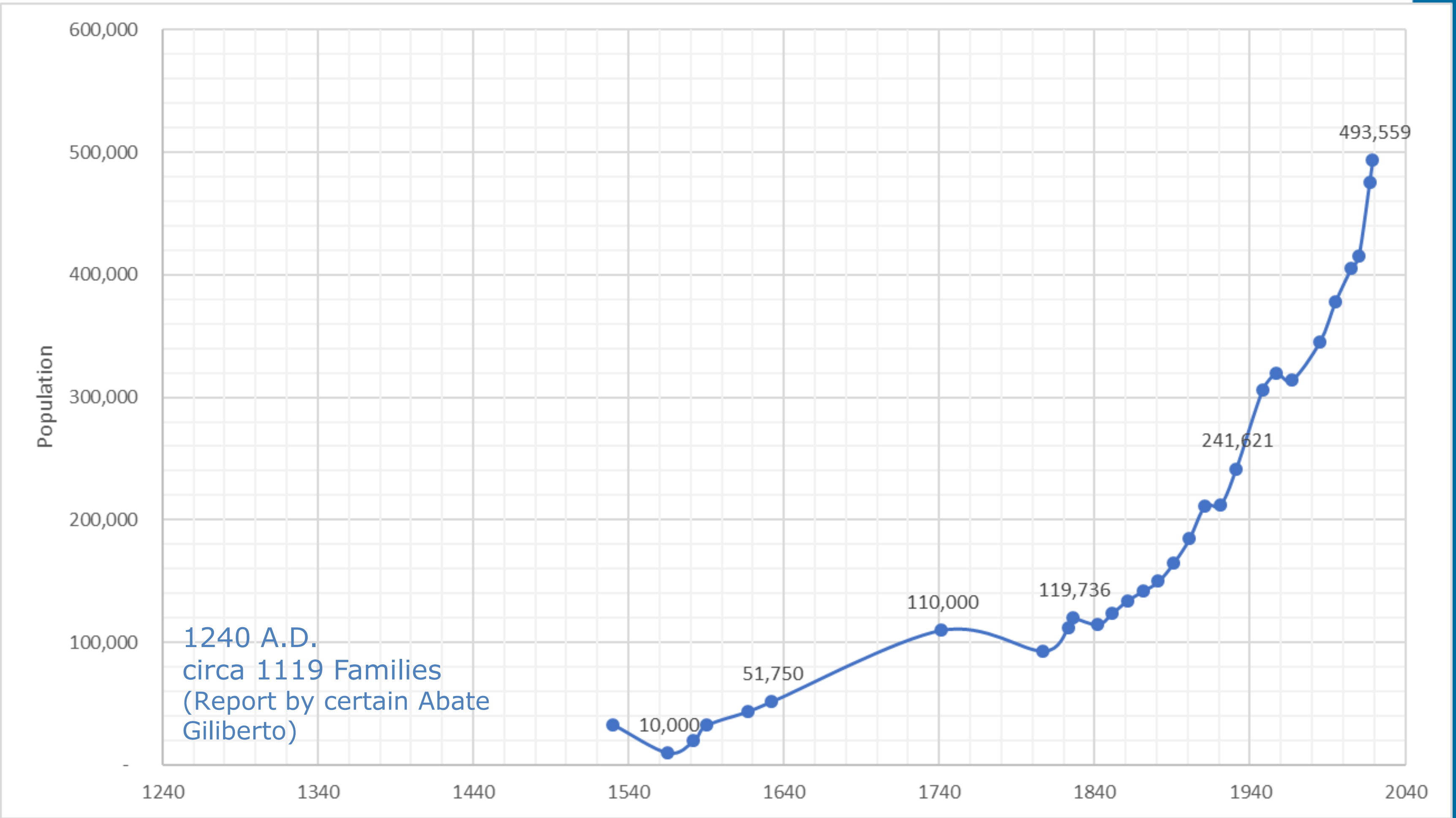
Population, Maltese Islands

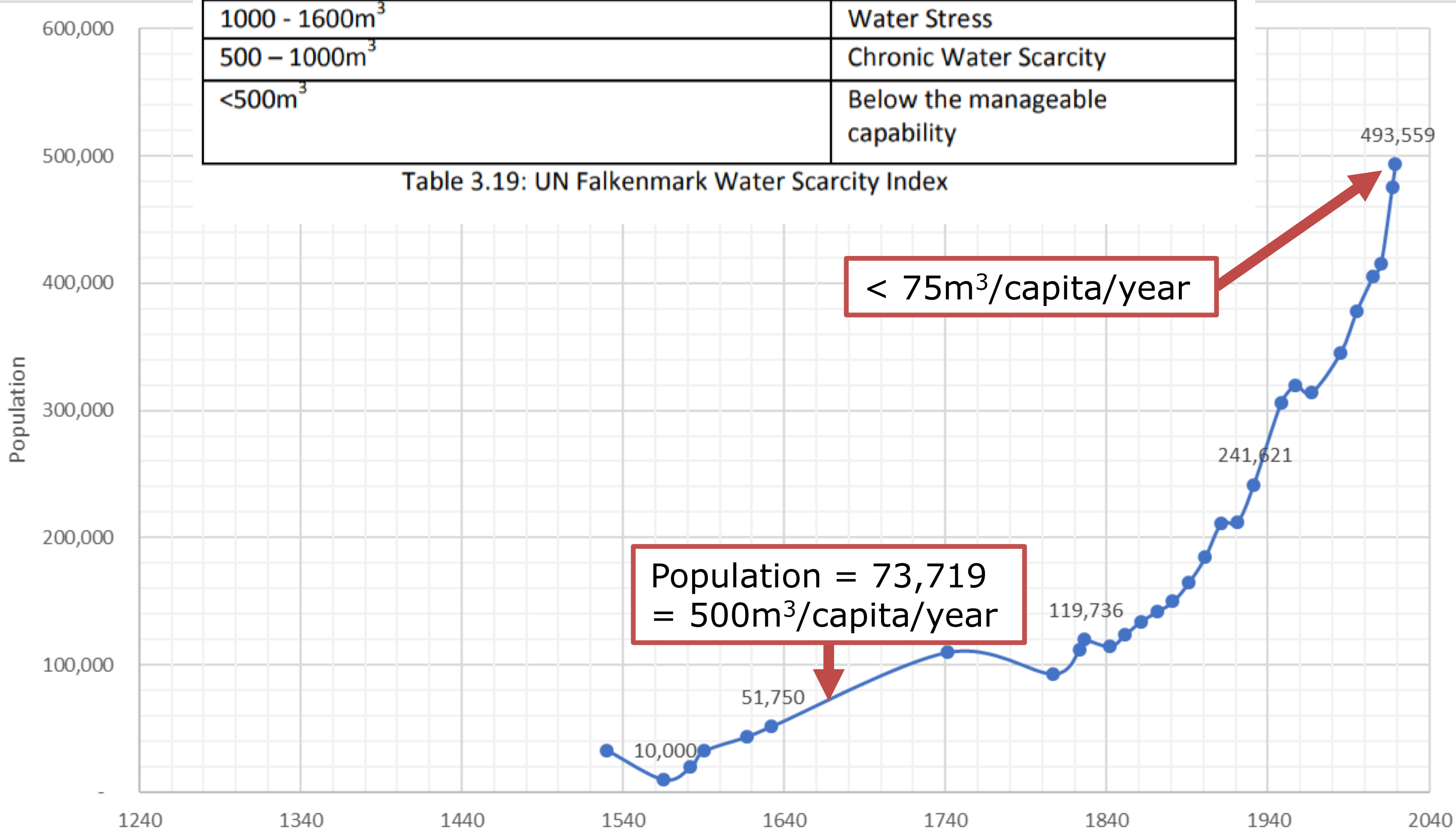


- Sources: NSO, Census taking in Malta, NSO, World Population Day 2019
- Census years: 1240, 1590, 1617, 1632, 1807, 1842, 1851, 1861, 1871,1881, 1891, 1901, 1911, 1921, 1931, 1948, 1957, 1967, 1985, 1995, 2005, 2010,
- Official censuses since 1842
- Other values are estimates

Mean Annual per Capita availability of Naturally Renewable Freshwater Resources

Mean Annual per Capita availability of Naturally Renewable Freshwater Resources	Classification
>1600m^3	Sufficient Availability
1000 - 1600m^3	Water Stress
500 – 1000m^3	Chronic Water Scarcity
<500m^3	Below the manageable capability

Table 3.19: UN Falkenmark Water Scarcity Index



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Natural Water Resources

Inland surface and transitional waters

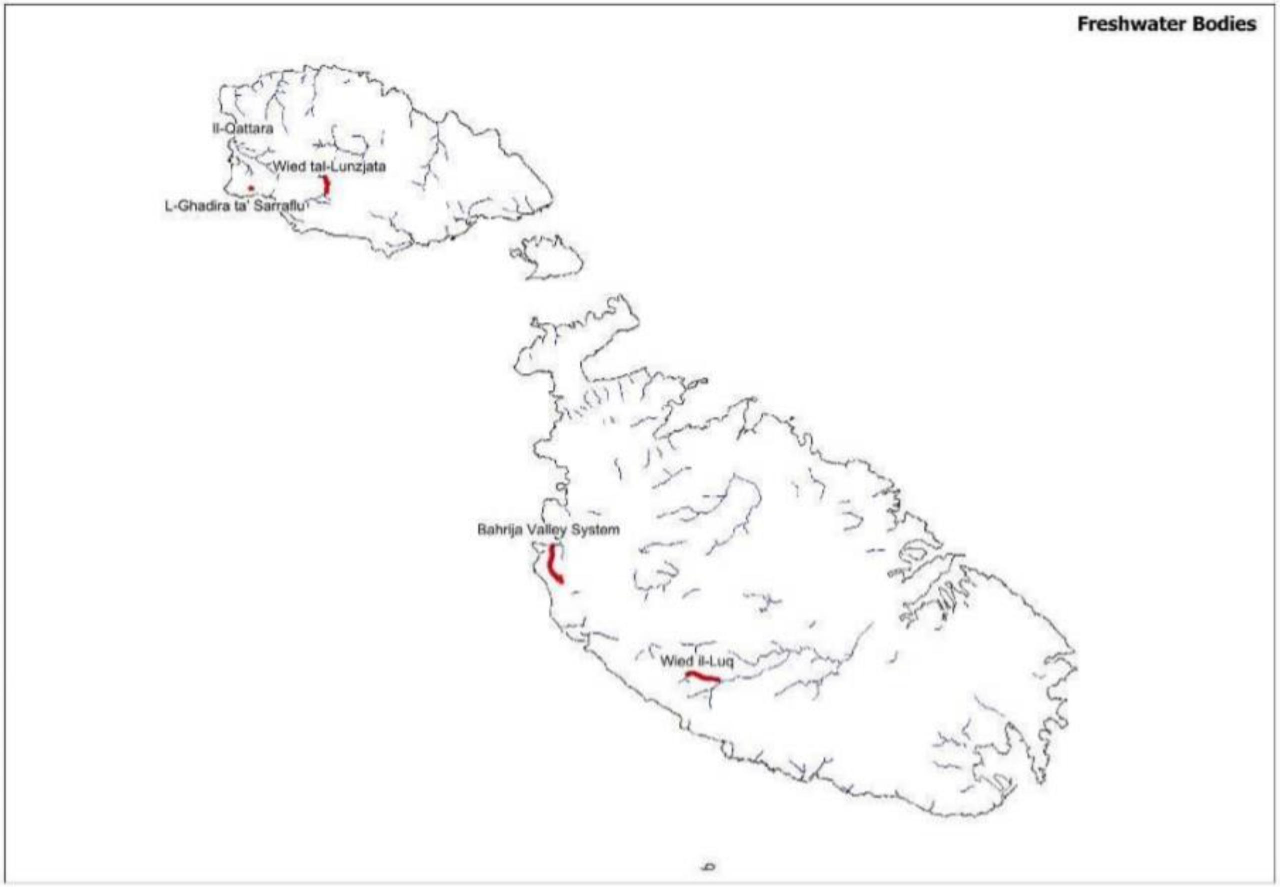

Figure 2.5: Small freshwaters in the Maltese Islands indicated by the red lines. The thin blue lines refer to the dry river valley systems considered to be of ecological significance in the Maltese Islands. Baħrija valley, Wied il-Luq and Wied Lunzjata (Gozo) are categorised as water courses. Il-Qattara and l-Għadira ta' Sarraflu (both located in Gozo) are freshwater pools.

Source: SEWCU & ERA (2015) The 2nd Water Catchment Management Plan for the Malta Water Catchment District 2015 - 2021

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Natural Water Resources
Inland surface and transitional waters

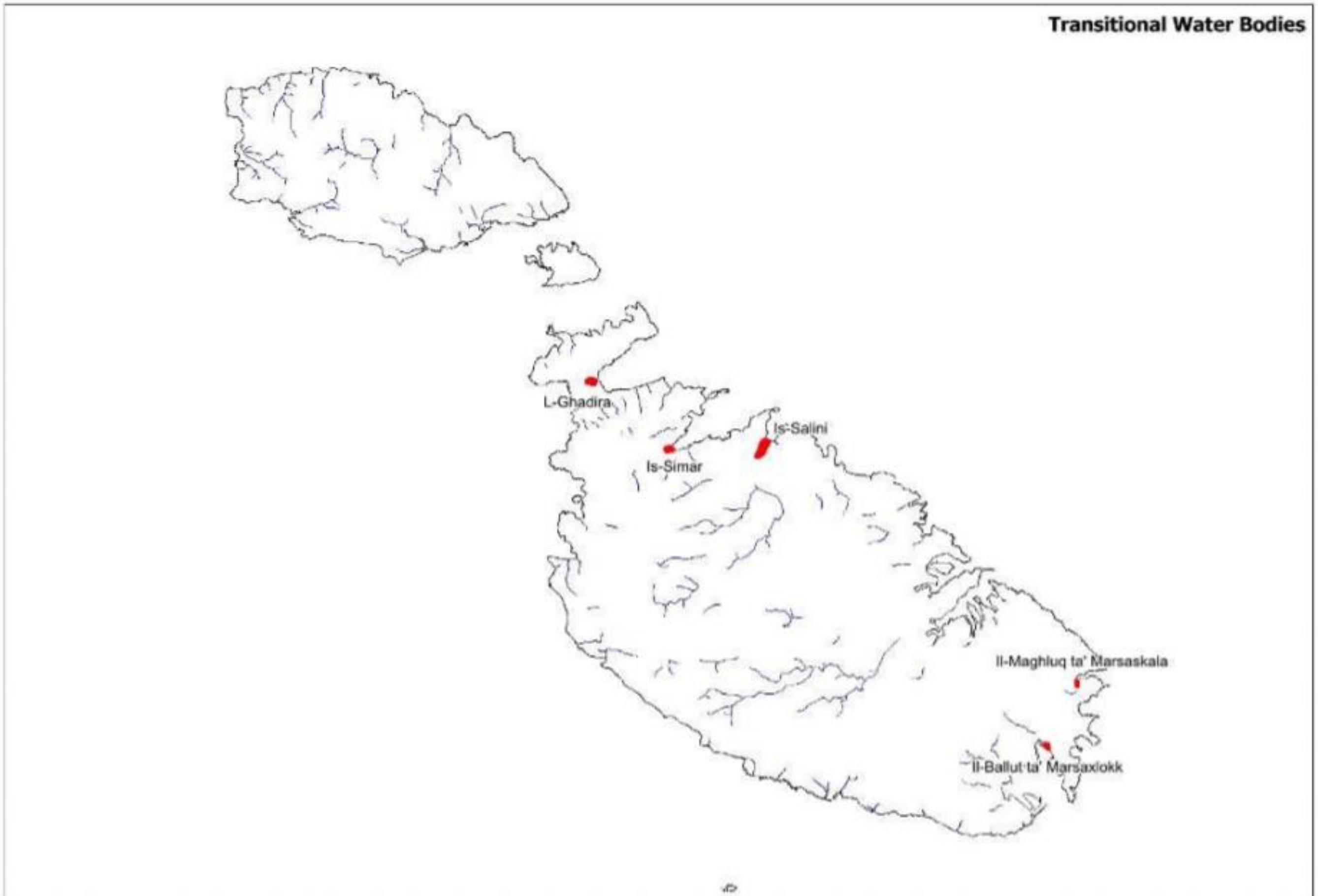


Figure 2.6: Transitional waters in the Maltese Islands are indicated by the red lines. The thin blue lines refer to the dry river valley systems considered to be of ecological significance in the Maltese Islands. Transitional waters are found at the mouths of dry valley systems

Source: SEWCU & ERA (2015) The 2nd Water Catchment Management Plan for the Malta Water Catchment District 2015 - 2021

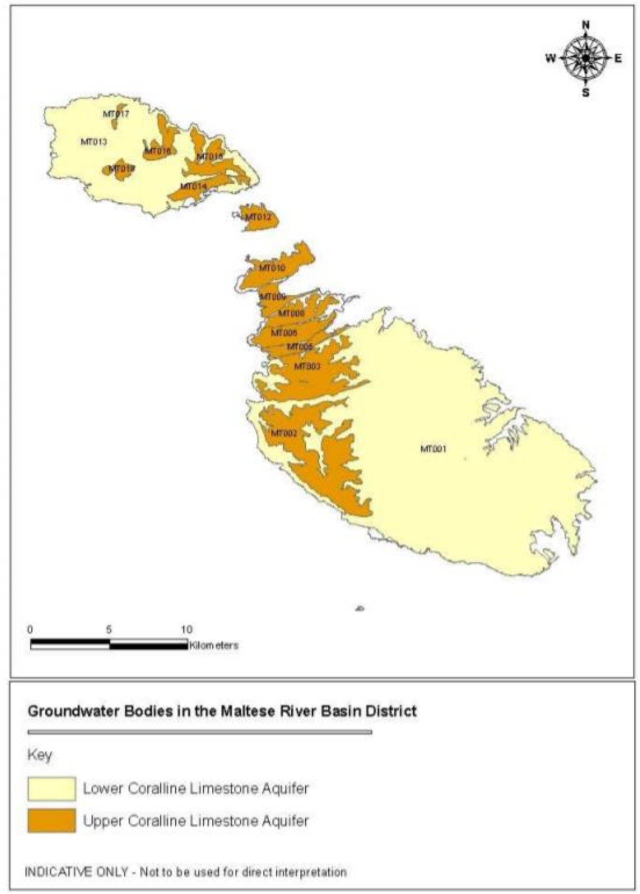
Natural Water Resources
Groundwater Bodies

Table 2.3

Groundwater bodies in the Maltese water catchment district

GWB Code	Name of the groundwater body (GWB)	Spatial Extent (km^2)
MT001	Malta Mean sea level	216.6
MT002	Rabat-Dingli Perched	22.6
MT003	Mgarr-Wardija perched	13.7
MT005	Pwales coastal	2.8
MT006	Mizieb Mean Sea Level	5.2
MT008	Mellieha perched	4.5
MT009	Mellieha coastal	2.9
MT010	Marfa coastal	5.5
MT012	Kemmuna Mean Sea level	2.7
MT013	Gozo mean sea level	65.8
MT014	Ghansielem perched	2.7
MT015	Nadur perched	5.0
MT016	Xaghra perched	3.0
MT017	Zebbug perched	0.4
MT018	Victoria-Kercem perched	1.5

Map 2.4
Designated groundwater bodies in the Maltese Water Catchment District



Source: MRA & MEPA (2011) The Water Catchment Management Plan for the Maltese Islands

Natural Water Resources
Groundwater Bodies

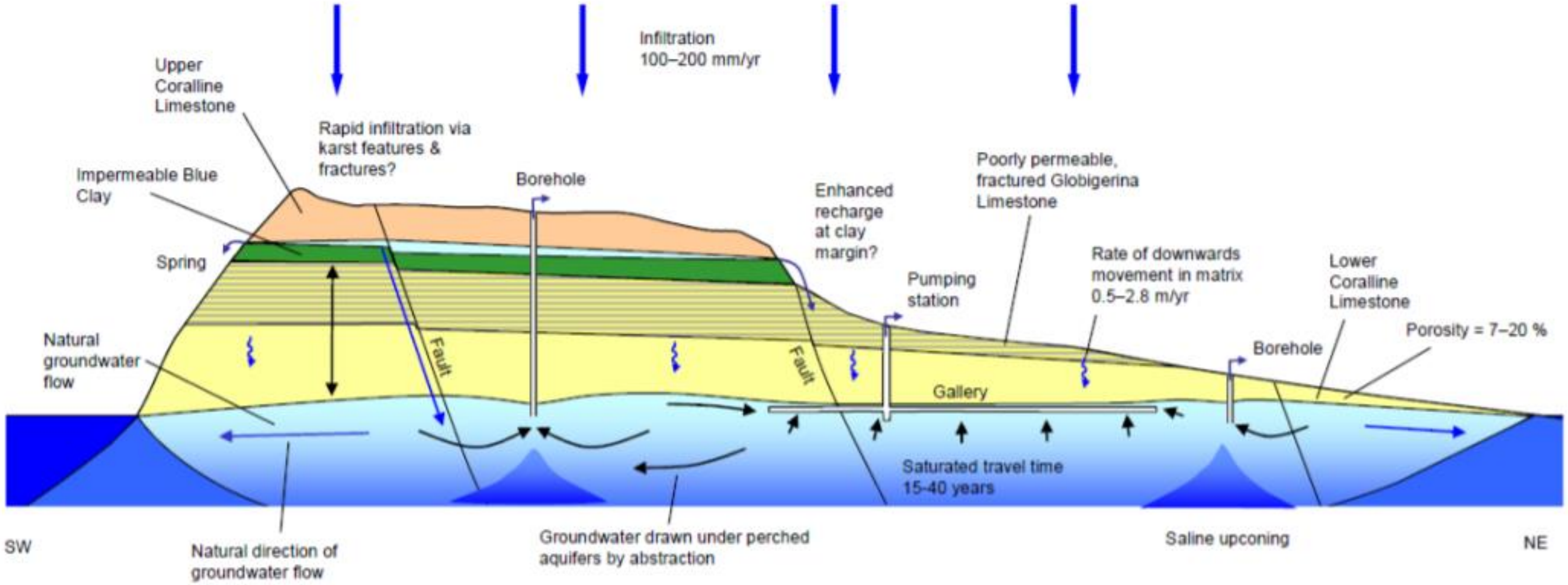
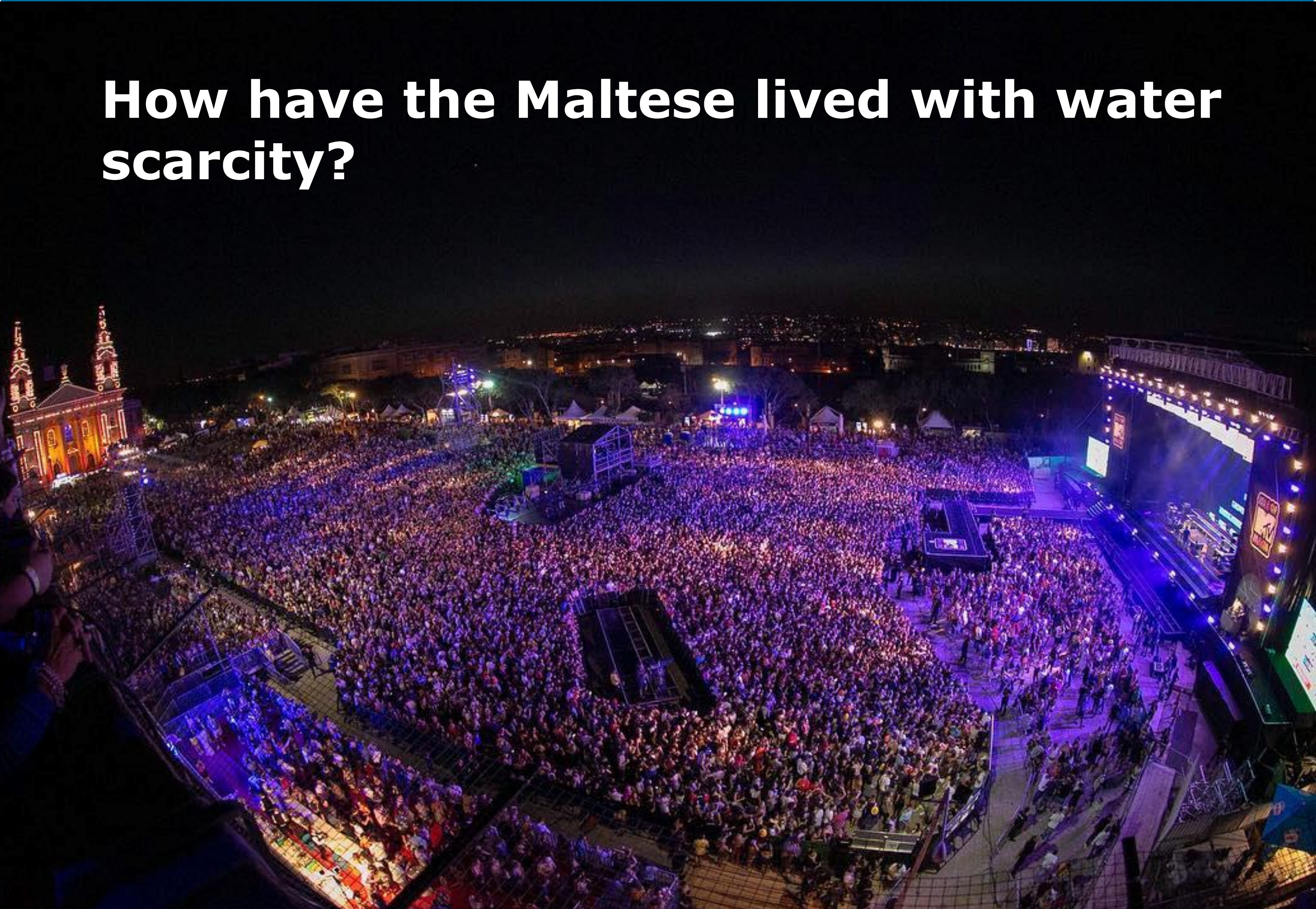


Figure 2.49: Conceptual Model of groundwater movement in the Malta Mean Sea Level Aquifer System

Source: MRA & MEPA (2011) The Water Catchment Management Plan for the Maltese Islands

How have the Maltese lived with water scarcity?



Source: tvm.com.mt

Historical Water Timeline…a brief one

- Neolithic Period
- Arab & Medieval Period
- Order of the Knights of St John
- British Period
- Post-independence
- Today

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Natural Springs

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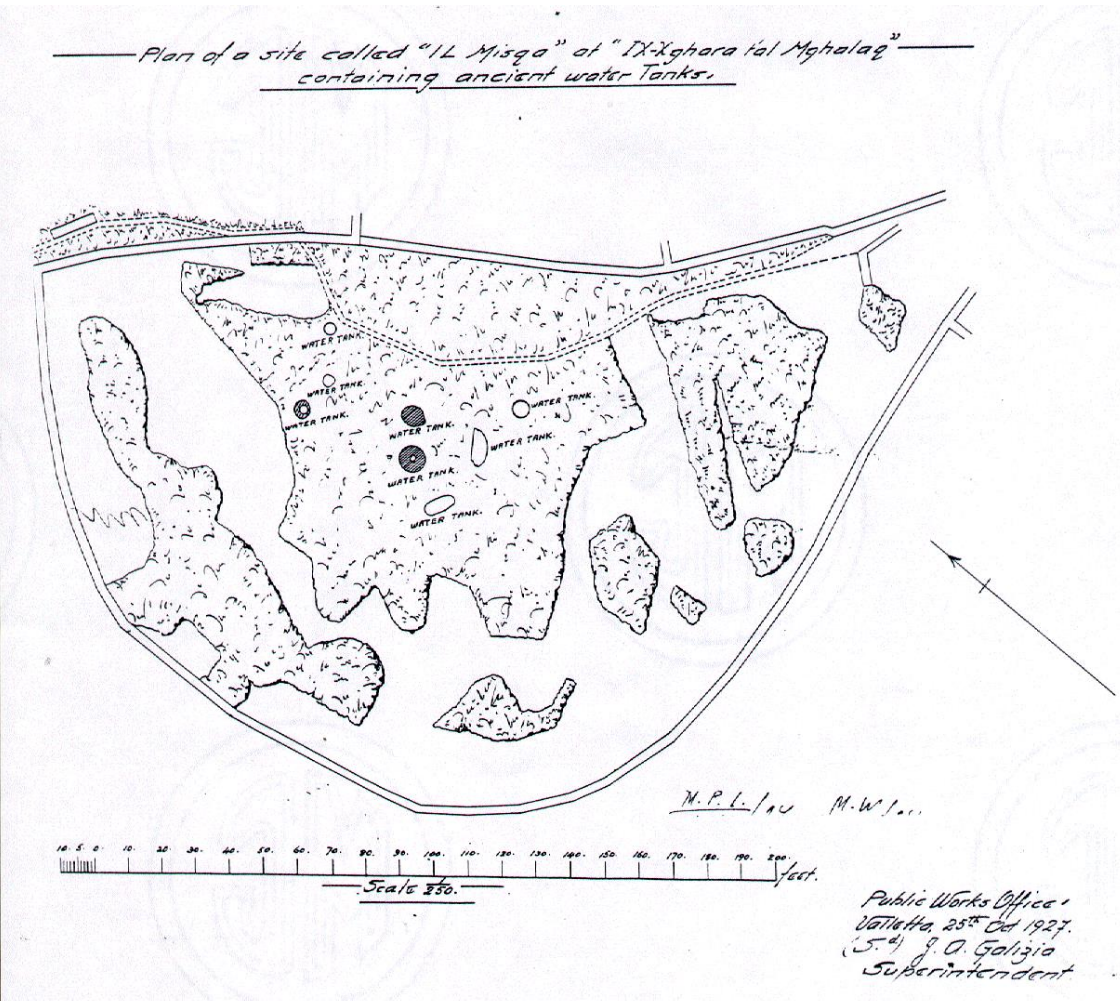
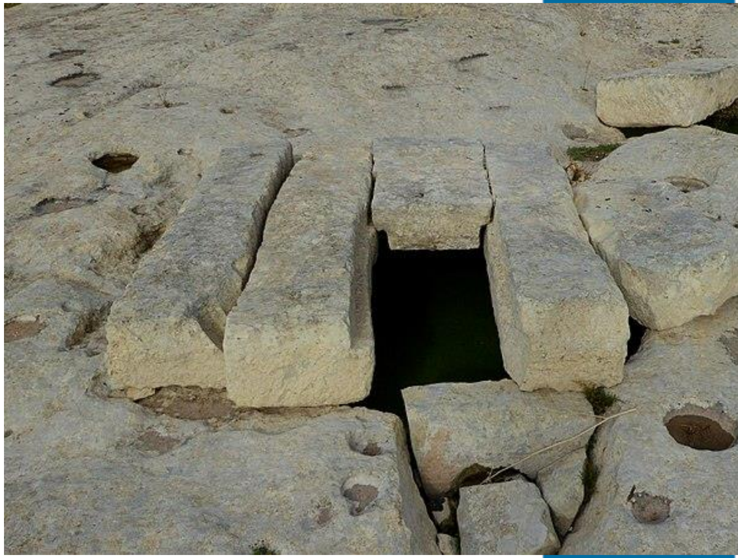
Prehistoric – Misqa Tanks (4500 - 2000 BC.)



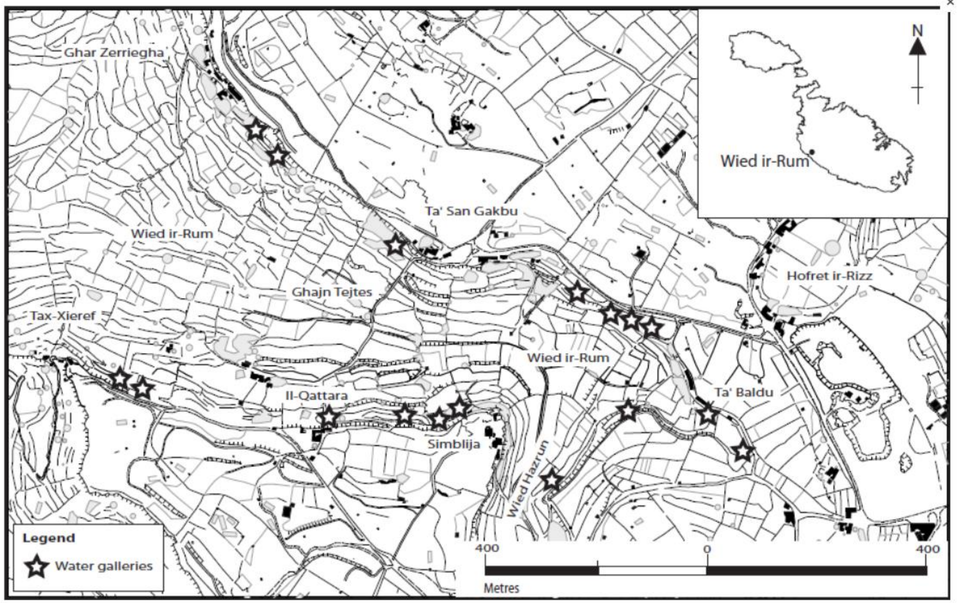
Site plan of the area dated 25th October 1927, as produced by Mr. J.A. Galizia Superintendent of the Public Works Office.
Source: http://qrendilocalcouncil.org.mt/



Source: Wikimedia Commons

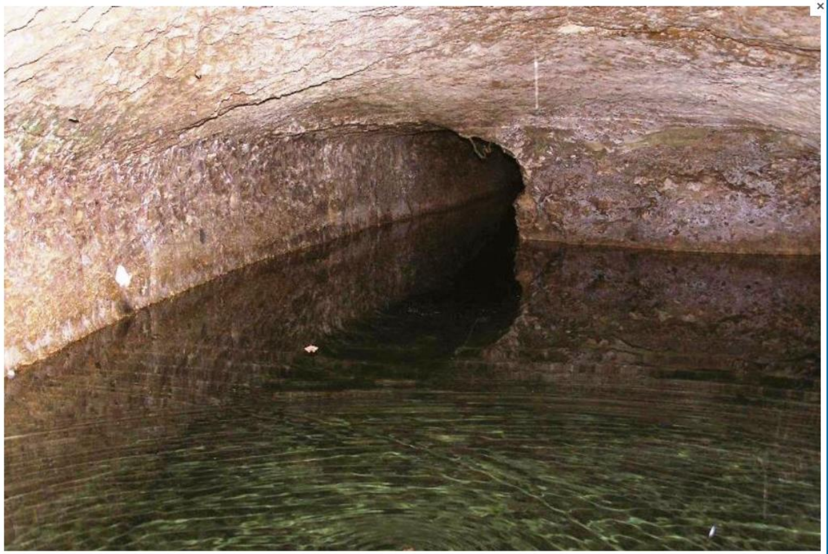
Artisan Galleries and Reservoirs

The late medieval water galleries in Malta (11th to 16th cent. AD)



Plan of the Wied ir-Rum and the adjoining Wied Ħażrun valleys showing the spatial distribution of the water galleries located within ©K.Buhagiar 1 / 6

The Lunzjata perched aquifer gallery and its fronting water reservoir, located in the territory of Rabat, Malta. ©K.Buhagiar 5 / 6



The Lunzjata perched aquifer gallery and its fronting water reservoir, located in the territory of Rabat, Malta. ©K.Buhagiar 6 / 6

Buhagiar, K. (2007) Water Management Strategies and the Cave-Dwelling Phenomenon in Late-medieval Malta. Medieval Archaeology, 51, pp. 103-131.

http://www.hydriaproject.info/

Case-study compiled in 2012-13 with the support of the Alter Aqua project of GWP-Med.

Order of the Knights of St John

"…The water is salty and putrid, but there are good springs which are probably due to rain fallen in winter time. The origin of these springs is not very deep, they often disappear in summer but the always dimmish in volume. One generally drinks rain water collected in tanks or in ditches…"

Knight Quintinus, 1536, Portrayal of Maltese water situation

Source: Sapiano et al. (2008)

Order of the Knights of St John

Detail from a watercolor depicting the construction of the new city of Valletta.

- Water availability considered during the planning and construction of the new city of Valletta
- Especially since Valletta had no natural water sources
- Commission appointed by the Grand Master Jean de La Vallette to draw up regulations for the building of the new city houses stated:

  "… *every hourse should have an underground tank for the collection of rainwater, under penalty of fifty scudi for failure to comply* …"
- Public drainage system connected to a network of pipes that carried sewage outside the city walls, preventing the risk of contamination of the rain-fed tanks from sewage leakage

Source: Sapiano et al. (2008)

Order of the Knights of St John

- By late 1500's water storage facilities within Valletta could not cope with the daily water demand and so a supply of water for Valletta had become a necessity, " *not only for its usefulness but also for its honor*"
- 1596 the Council of the Order decreed that a project to " convey spring water from the western hills to the city had to be carried out"
- Two dry exceptionally dry years (1608, 1609) pressed Grandmaster Wignacourt.
- Aqueduct started in 1610, commissioned in 1615, capacity of 1,400 m3/day to supply 30,000 people living in the cities
- Inhabitants of the rural villages depended on local underground cisterns
- Wignacourt Aqueduct continued to provide water to cities, with an increase in population which reached 114,000 (1798). Led to increase in population and development of towns and villages alongside the route of the aqueduct - Attard, Lija, Balzan, Mosta, Zebbug, Hamrun, Qormi, Floriana and Valletta

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Source: Sapiano et al. (2008)

Order of the Knights of St John

British Period

- Dry years 1834-1841 led to construction to second aquaduct: Fawwara Aquaduct
  - Rabat/Dingli to Cospicua, Vittoriosa and Senglea, Luqa, Mqabba, Tarxien and Paola.
  - 275 m^3/day
  - Both aqueducts supplied from perched aquifer
- 1864-1866 – Sinking of 175 shafts an driving of 8.3 km of gallers in UCL
  - Newly developed springs connected to Wignacourt aqueduct increasing output by 700 m^3/day

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Source: Micallef et al. (2001)

British Period

- 1865 chlorea epidemic highlighted the lack of quality of potable water in private and public underground cisterns contaminated by leaking sewers, cesspits and animal excreta.
- Report by Dr Sutherland 1867:
  - Samples taken from aqueducts and distribution tanks suitable for potable purposes
  - Water from underground cisterns found to be highly contaminated
- Early 1900s two serious typhoid outbreaks – leaching of manure into perched aquifers feeding aqueducts
- 1909, Sir Temi Zammit and Major A.H. Morris recommended chlorination
- Closed pipes instead of open channels
- Initiation of routine water quality control programme with results documented.

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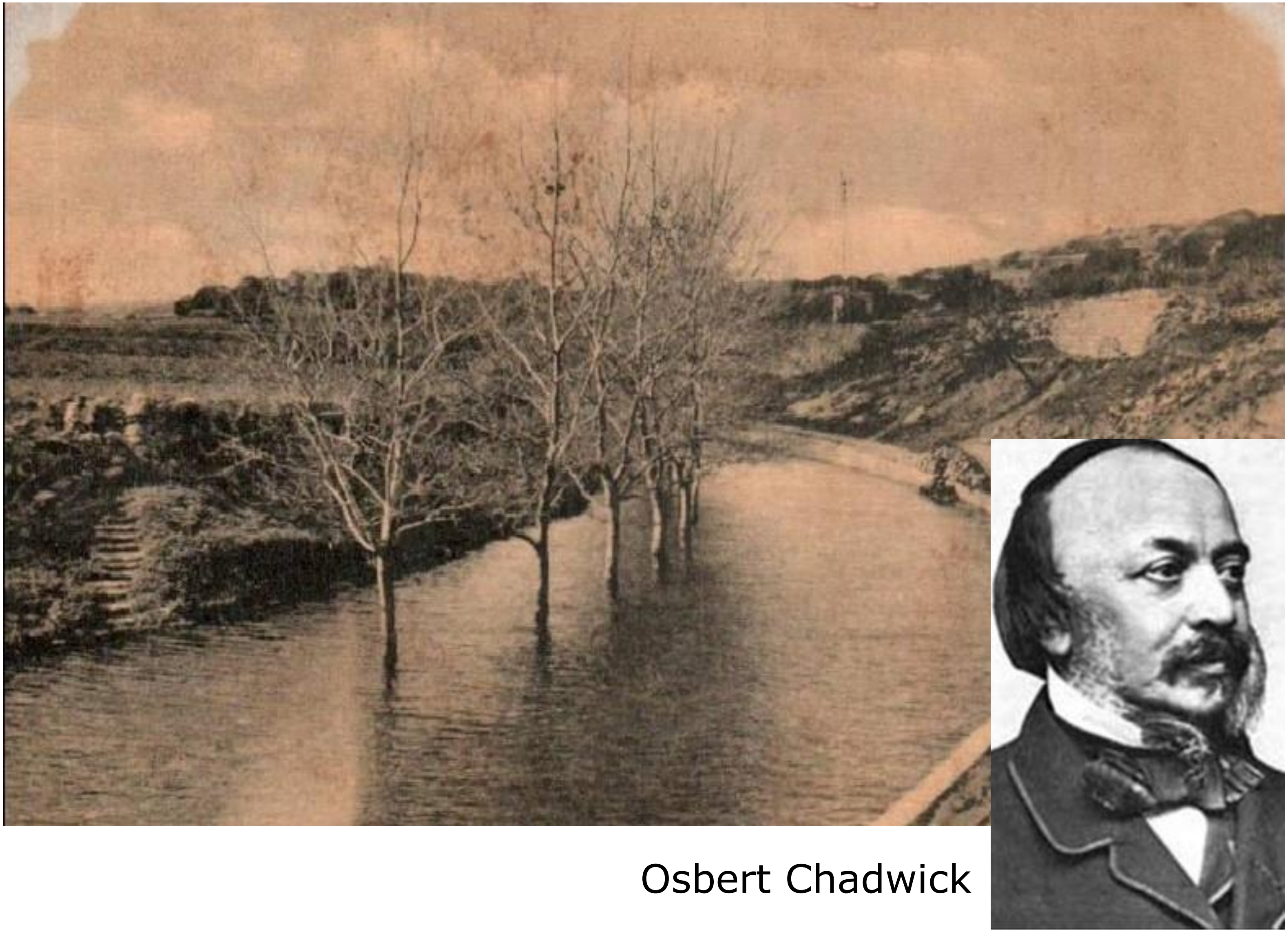
Source: Micallef et al. (2001)

British Period - Chadwick



Osbert Chadwick

British Period - Chadwick

Replenishment of MSLA via stormwater

- Morris (1952), para. 170.
  - "… a large part of the replenishment of the Main Sea Level Table takes place through the small inliers of Lower Coralline Limestone which outcrop in the central region of the island… It follows, therefore, that every effort should be made to conserve these outcrops, and all the channels which drain into them, in as clean and effective a condition as possible. Their importance in the Island's water supply regime is completely out of proportion to the relatively small superficial area which they occupy. It should be arranged that any planned redistribution of the congested village populations of the interior shall take place in directions away from these inliers…"

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British Period - Galleries

British Period - Galleries

Table 1. Details of galleries and stations in the Mean Sea Level Aquifer

Name of pumping station	Year of completion	Number of galleries	Total length (m)	Bench mark amsl (m)	Depth of main shaft (m)
Wied il-Kbir	1887	6	4200	24.48	6.21
San Anton	1896	1	N/A	50.23	48.59
Hlas	1918	6	5100	29.19	29.58
Wied Dalam	1925	3	1650	21.21	23.94
Wied il-Ghasel	1926	14	2680	45.51	14.57
Speranza	1956	8	5500	63.90	69.68
Bakkja	1957	6	5400	92.57	100.24
Qali	1961	6	5400	92.87	100.17
Kandja	1963	6	6100	92.51	97.46

Table 2. Details of galleries and stations in the perched aquifer

Name of pumping station	Year of completion	Number of galleries	Total length (m)	Bench mark amsl (m)	Depth of main shaft (m)
Dingli Road	1885	4	1800	207.36	15.02
Ghajn Qajjed	1926	N/A	N/A	N/A	N/A
Mizieb	1957	5	650	56.84	69.64
Bingemma	1960	5	2800	114.53	121.36
Falka	1960	4	500	104.11	93.02
Mgarr	1962	3	220	90.50	33.50

Source: Micallef et al. (2001)

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British Period - Galleries

- Morris (1952), para. 164.
  - "…There shall be no doubt that the time-honored method of driving galleries at sea level is the most economical and satisfactory way of extracting potable water from a sea level table contained in such formations as the Lower Coralline and Globigerina Limestone of Malta. The results of borehole pumping have proved very disappointing… But as a long term policy, borehole pumping is most unsuitable, under local conditions, for the extraction of water on a large scale for public supplies, owing to the high cost per gallon of water raised and the local accentuation of salinity in the upper layers of the water table which each borehole must inevitably produce."

Post-independance

Source: *timesofmalta.com*

Post-independence - Desalination

Post-independence - Desalination

Source: WSC

Post-independence - Desalination

Location	Commissioned	Feedwater	Capacity
Lapsi	1986: 20,000 m^3/day 1986: increased to 24,000 m^3/day	Seawater	24,000 m^3/day
Marsa	1983	Brackish water	4,500 m^3/day
Cirkewwa	1989	Seawater	18,600 m^3/day
Pembroke	1991: 17,600 1993: 8,800 1994: 27,600 m3/day	Seawater	54,000 m^3/day
Hondoq ir-Rummien (Gozo)	2020	Seawater	9,000 m^3/day

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Post-Independence – Wastewater Reuse

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Today

- European Legislation
  - Groundwater Directive (2006/118/EEC)
  - Nitrates Directive (91/676/EEC)
  - Bathing Water Directive (2006/7/EC)
  - Drinking Water Directive (98/83/EC)
  - Floods Directive (2007/60/EC)
  - Sewage Sludge Directive on the protection of the environment and in particular of the soil when sewage sludge is used in agriculture (86/278/EEC), as amended by 91/692/EEC
  - Urban Wastewater Treatment Directive (92/271/EEC)

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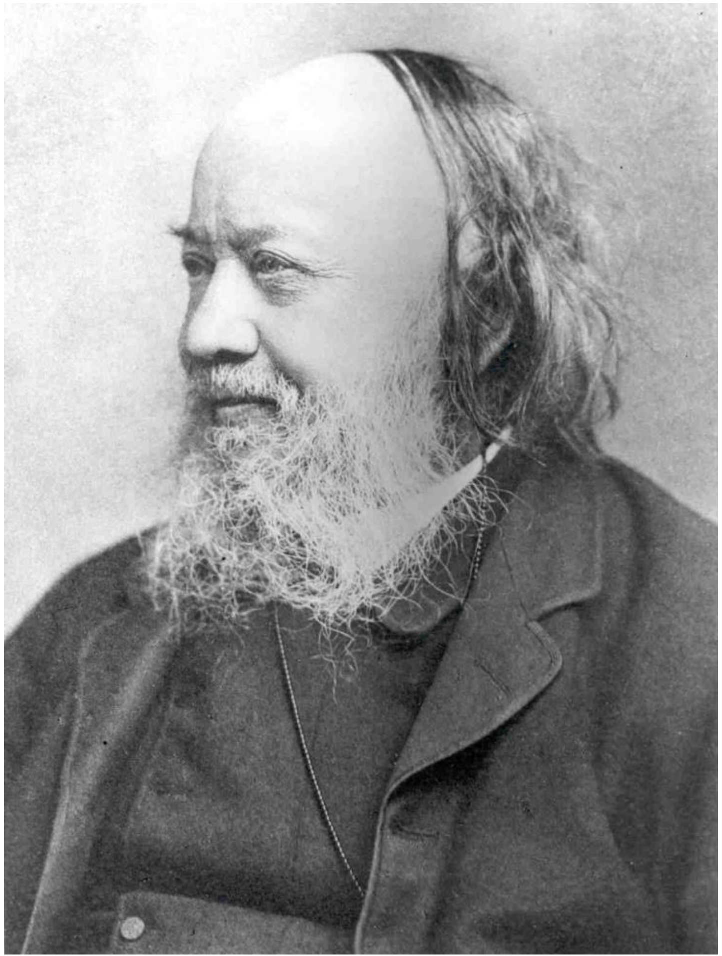
Today – Wastewater treatment

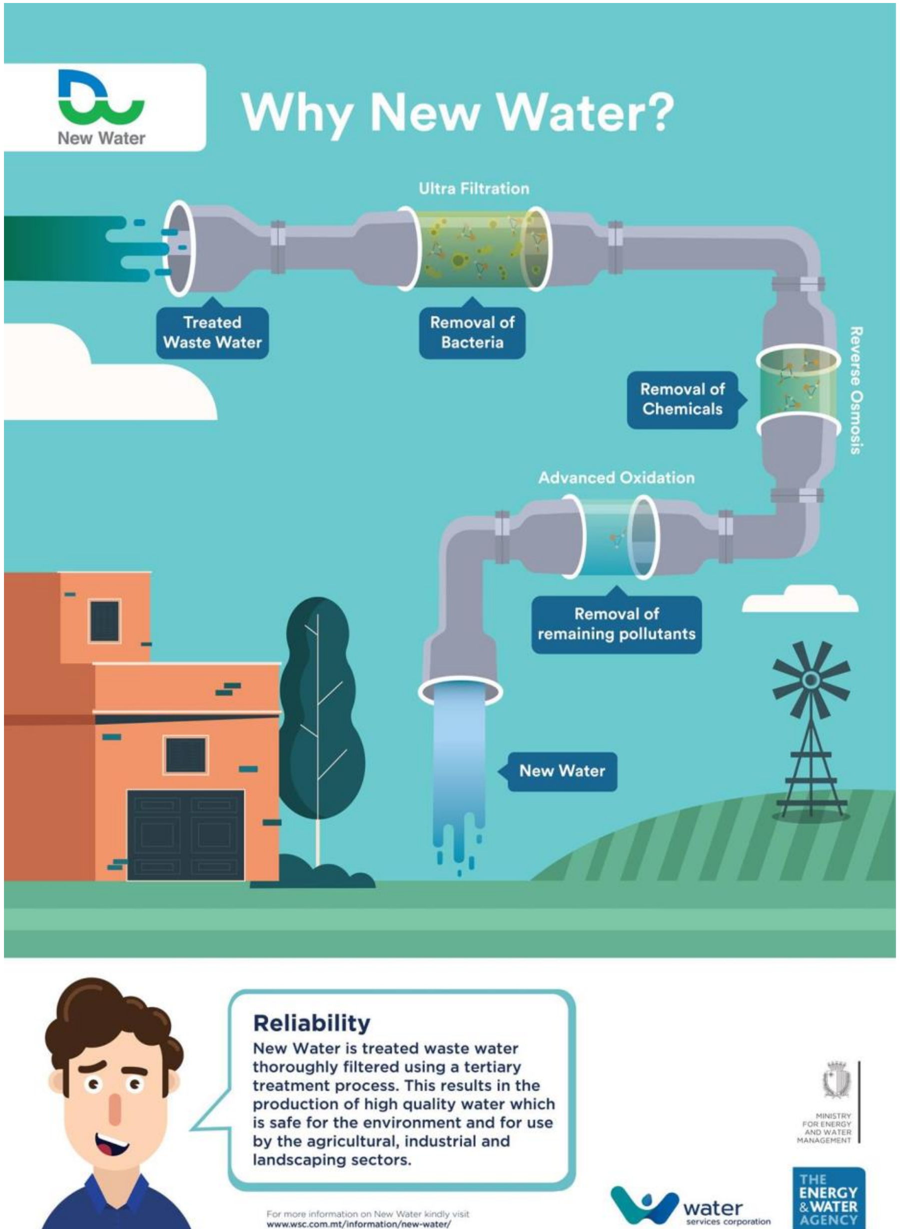
Wastewater reclamation

"the rain to the river and the sewage to the soil"



Sir Edwin Chadwick (1800 -1890)
(father of Osbert Chadwick)

Wastewater Reclamation



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Observations from the past:

- Throughout history - supply driven by demand
- Public ownership of common water resources
- Public awareness and strong appreciation of value of water through scarcity conservation
- Public perceptions on quality of treated wastewater
- Public perceptions on quality of municipal tap water

Considerations for the future

- Continuous monitoring
- Eco-system services
- Life-cycle approach
- Participatory IWRM

References

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Thank you for your Attention

Any questions?

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